THE HEATING AND VENTILATING MAGAZINE

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# Heating and Ventilating Plant of a Detached College Building

BY R. E. CHANDLER

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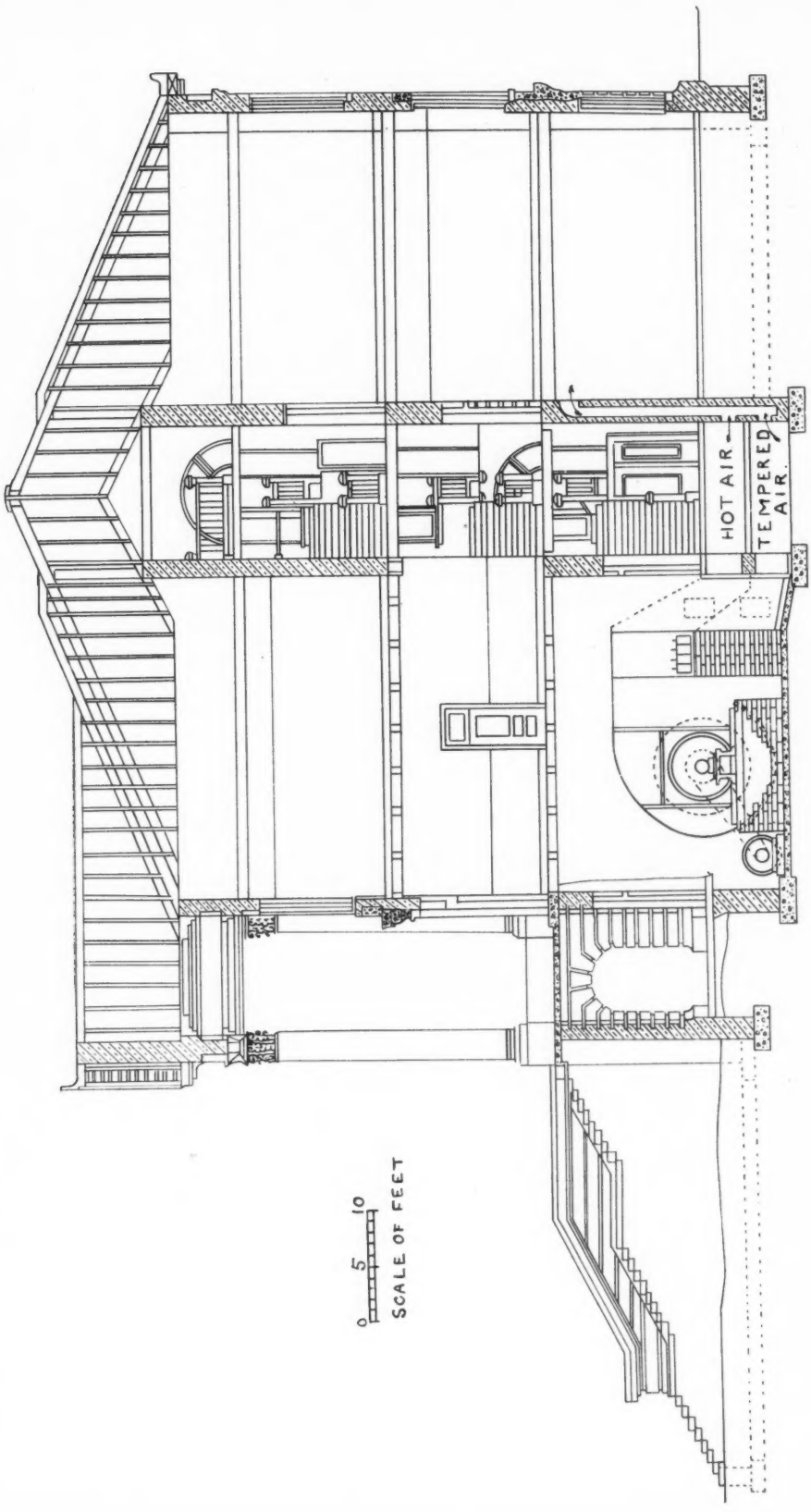
An examination of the record of temperature kept by the Oklahoma Experiment Station at Stillwater, Oklahoma, shows that during each of six months in the year there are some days on which a heating plant must be run in order to maintain the temperature at 70 degrees and that during these six months there are apt to be short spells of zero weather. The temperature is sometimes considerably below zero. During the winter of 1898–1899 a temperature of 24 degrees below zero was recorded. From about the middle of November until the middle of March the heating plants have to be run practically every day.

It will be seen from the above facts that the amount of heating surface required is about the same as for more northern climates, as the required amount must be sufficient to maintain the temperature in zero weather, although the average temperature during the winter is higher than that of any of the northern States.

AGRICULTURAL BUILDING, OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE

The heating and ventilating plant here described has been installed in a building completed this summer for the Oklahoma Agricultural and Mechanical College, at Stillwater, Oklahoma. The building is 166 feet long and 70 feet wide, and three stories high. It is built of pressed brick and Bedford stone. The building is used principally for class rooms by the



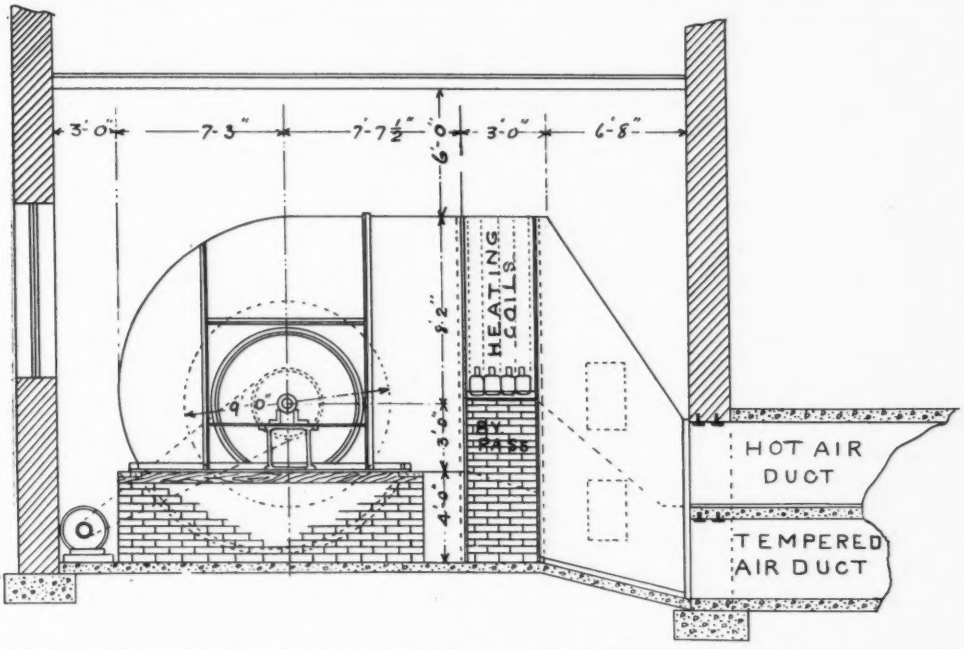

CROSS SECTION OF AGRICULTURAL BUILDING, OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE, SHOWING LOCATION OF FAN AND DUCTS

Agricultural Department of the college, but it also contains the offices of the president of the college and the Director of the Experiment Station.

The building is heated and ventilated by means of a forced blast system. There are no boilers in the building, steam being furnished from a central heating plant 300 feet distant. The water of condensation flows back to a pump pit at the central heating plant, whence it is pumped to the boilers by a 5¼-inch x 3½-inch x 5-inch Knowles receiver pump. The steam main from the central heating plant is 6 inches in diameter and the return pipe, 3½ inches. Both pipes are covered with magnesia sectional covering over which is wrapped heavy tar paper, and the whole given a coat of asphaltum paint. The two pipes are enclosed in 18-inch split tile.

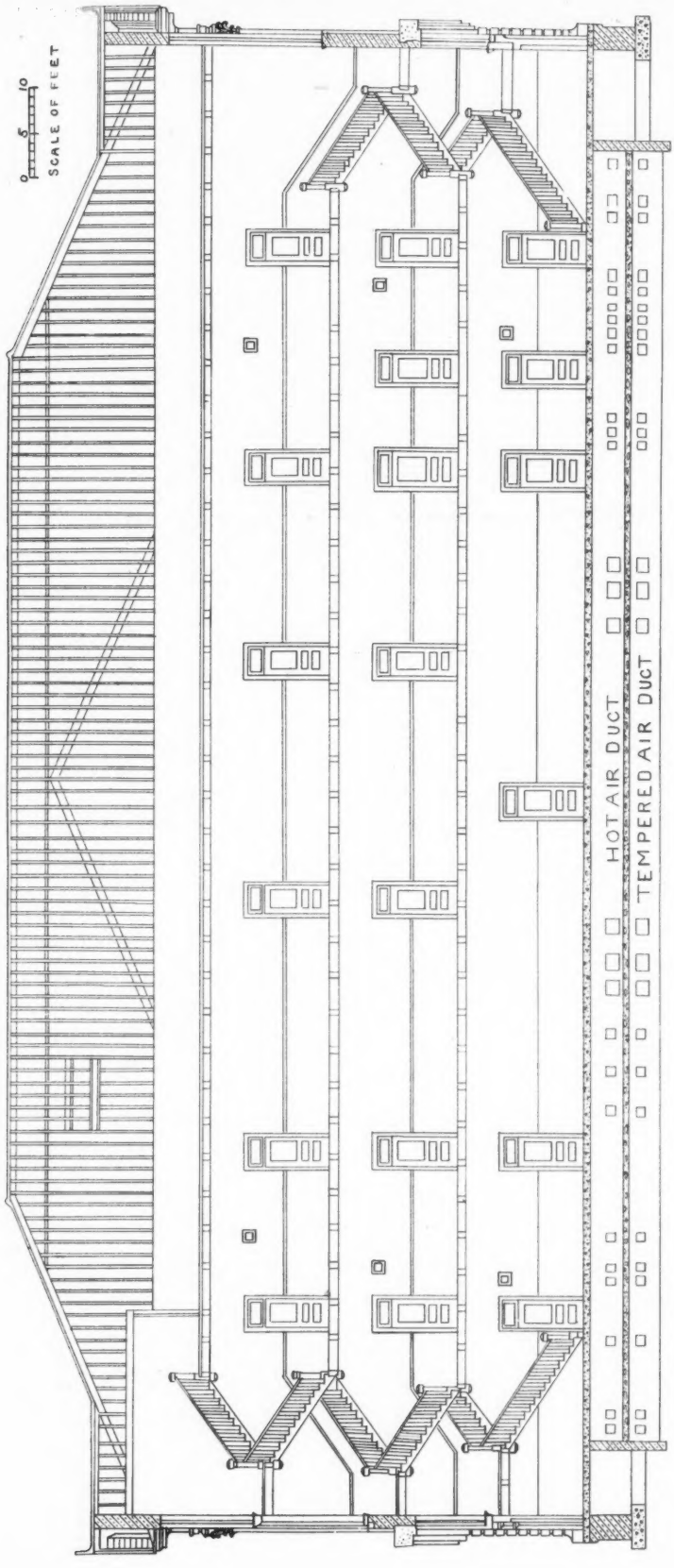
The exhaust steam of two 10-inch x 10-inch automatic engines located at the central heating plant is run through a grease separator before passing into the main mentioned above. Provision is also made for taking live steam from the boilers through a reducing valve. The building contains approximately 480,000 cubic feet. There is installed 9,600 feet of 1-inch pipe in the heating and tempering coils, of which the tempering coils contain 1,920 feet.

The fan which is 9 feet x 4½ feet, three-quarter housing, is driven by a 15 H. P. D. C. motor, the current being furnished at a pressure of 220 volts. A louvre damper beneath the tempering coil controlled by a thermostat situated in the tempered air duct serves to keep the temperature in the tempered air duct at 65 degrees. The air having passed through the heating coils passes into the hot air duct. A by-pass below the heating coils allows air to pass into the tempered air duct. These two ducts are each 3½ x 12 feet in cross section and extend beneath the corridor of the first floor almost the entire length of the building, thus doing away with the necessity of using unsightly galvanized iron pipes.

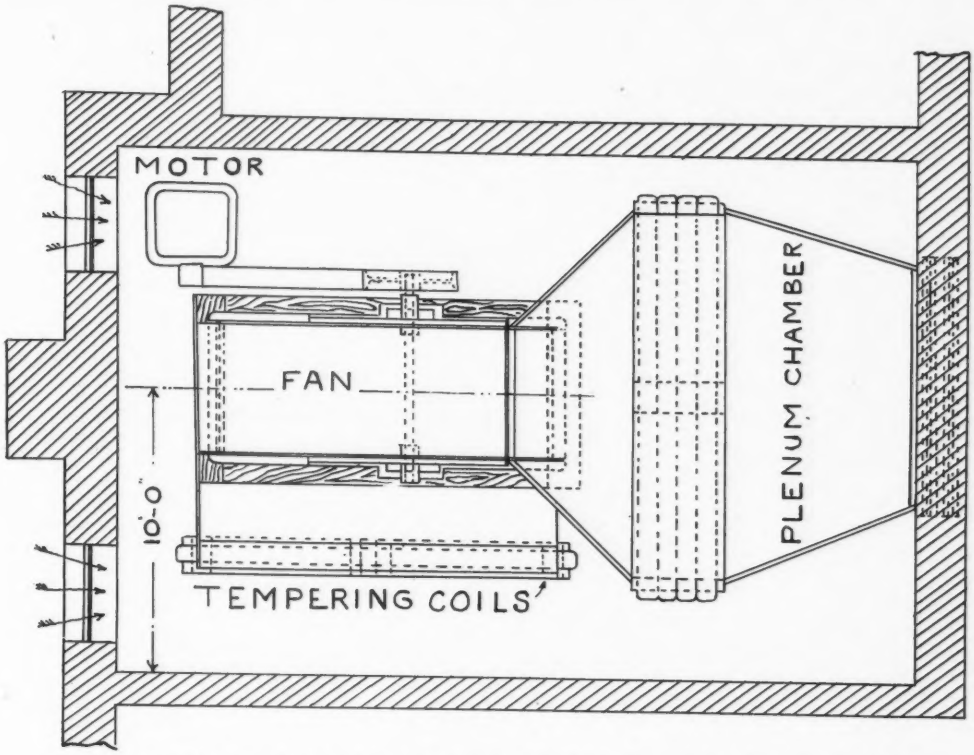



SIDE ELEVATION OF FAN ROOM, OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE

To each room a vertical flue extends, having an opening into the hot air duct and also into the tempered air duct. Dampers, controlled by a thermostat in each room, are placed in these openings. All heat and vent flues are located in the two 21-inch walls which form the sides of the corridor. The vent flues pass to the attic, the foul air escaping



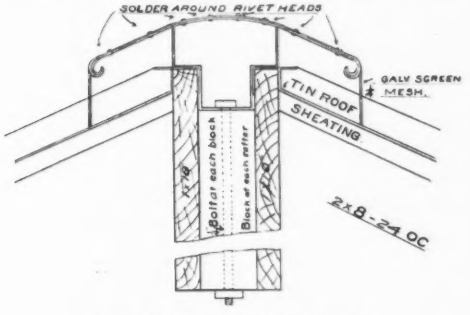

LONGITUDINAL SECTION, AGRICULTURAL BUILDING, OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE, SHOWING ARRANGEMENT OF DUCTS AND LOCATION OF FLUES




PLAN OF FAN ROOM, OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE

from this attic through a ridge ventilator.

In a few of the rooms which are used only occasionally automatic regulation is not supplied. For these rooms the heat flue opens only into the hot air duct, the temperature




DETAIL OF RIDGE VENT

being regulated by opening or closing a register in the wall.

The compressed air for the automatic regulation is supplied by a small air compressor driven from the shaft of the fan, the writer having found this much more satisfactory than an air compressor driven by either water power or an independent electric motor.

This plant was designed by the writer. The fan heating coils and motor were manufactured by the B. F. Sturtevant Co. The temperature regulation was installed by the Johnson Service Co. S. A. Layton & Co., of El Reno, Oklahoma, are the architects of the building.

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A system of co-operative engineering has been devised by the University of Cincinnati, with the co-operation of about 35 of the largest mechanical and electrical manufacturing companies of Cincinnati and vicinity. The project contemplates a working arrangement whereby practical technical knowledge will be obtained in the factories, and the theory of engineering at the university; thus having the education of the head and hand progress together. Each one of the co-operating firms agrees to permit from two to ten of their apprentices to pursue a special six-year course at the university during alternate weeks.

# Features of Exhaust Steam Heating

By Charles L. Hubbard

Steam after being used in an engine contains the greater part of its heat, and if not condensed or used for other purposes it can usually be employed for heating without affecting to any great extent the power of the engine.

In general, we may say that it is a matter of economy to use the exhaust for heating, although various factors must be considered in each case, to determine to what extent this is true. The more important considerations bearing upon the subject are: the relative quantities of steam required for power and for heating, the length of the heating season, the type of engine used, the pressure carried, and, finally, whether the plant under consideration is entirely new or whether, on the other hand, it involves the adapting of an old heating system to a new plant.

The first use to be made of the exhaust steam is, of course, the heating of the feed-water, as this effects a constant saving both summer and winter, and can be done without materially increasing the back pressure on the engine.

Under ordinary conditions about 1-6 of the steam supplied to the engine can be used in this way, or more nearly 1-5 of the exhaust discharged by the engine.

We may assume in average practice that about 80 per cent. of the steam supplied to an engine is discharged in the form of steam at a lower pressure, the remaining 20 per cent. being partly converted into work and partly lost through condensation.

The latent heat in a pound of steam at atmospheric pressure is 966; therefore, out of each pound of live steam furnished to the engine there will be 966x.8 = 773 heat units available for heating purposes. It requires practically 210—50 = 160 heat units to raise one pound of feed-water from 50 degrees to 210 degrees; and this is $\frac{160}{773} = \frac{1}{4.8}$ or about 1-5 of the available exhaust. Taking this into account, there remains for other heating purposes .8x4-5 = .64 of the entire quantity of steam supplied to the engine.

When the quantity of steam required for heating is small compared with the total amount supplied to the engines, or where the heating season is short, it is often more economical to run the engines condensing and use live steam for heating. This can be determined in any particular case by computing the saving in fuel by the use of a condenser, taking into account the interest and depreciation on the first cost of the condensing apparatus, and the cost of water if it must be purchased. and comparing it with the cost of heating with live steam.

Usually, however, in the case of office buildings and institutions, and commonly in the case of shops and factories, especially in northern latitudes, it is advantageous to use the exhaust for heating, even if a condenser is installed for summer use.

The principle objection to the use of exhaust steam for heating has been the higher back pressure required on the engine. There are two ways of offsetting this loss; one by raising the initial or boiler pressure, and the other by increasing the cut-off of the engine.

Engines are usually designed to work most economically at a given cut-off, so that in most cases it is undesirable to change the cut-off to any extent. Raising the boiler pressure, on the other hand, is not so objectionable if the increase amounts to only a few pounds.

A modern heating plant with ample mains and branches should circulate freely on a pressure not exceeding 2 pounds, and good results are often obtained on one pound of even less.

The systems of steam heating in common use are those in which the water of condensation flows back to the boiler by gravity. When exhaust steam is used the pressure is

much below that of the boiler and the condensation must be returned either by a return trap or pump.

As the exhaust steam is often insufficient to supply the entire heating system, it must be supplemented with live steam taken directly from the boiler.

This must first pass through a regulating valve in order to reduce the pressure to that carried on the heating system.

An engine does not deliver steam continuously but at regular intervals at the end of each stroke, and further the amount will vary with the work done.

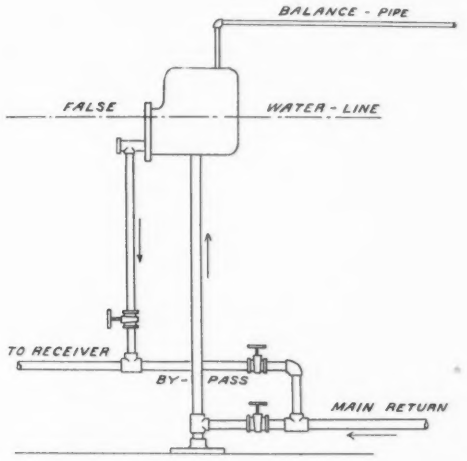



FIG. 1. STEAM TRAP CONNECTED FOR USE AS A WATER-LINE TRAP

When the work is light very little steam will be admitted to the engine, and for this reason the supply available for heating will vary somewhat, depending upon the use made of the power. In mills the amount of exhaust steam is practically constant; in office buildings where the exhaust is obtained from a lighting plant, the variation is greater, especially if power is also supplied for running elevators.

In order to make the steam supply automatic, the system must be equipped with both a reducing valve and a relief or back-pressure valve. The former for admitting live steam when the exhaust is not sufficient to maintain the required pressure, and the latter to allow the surplus to pass outboard when the quantity is greater than can be condensed in the heating system. Before entering the heating main the exhaust should be passed through a good form of oil separator, and it is well to still further purify the return by the use of a settling chamber.

Any of the usual systems of piping may be used, but great care should be taken that as little resistance as possible is introduced at bends and fittings; and the mains and branches should be of ample size. Usually the best results are obtained from the system in which the main steam pipe is carried directly to the top of the building, the distributing pipes run from that point, and the radiating surfaces supplied by a down-flowing current of steam.

Pipe sizes should generally be based on a drop in pressure of $\frac{1}{4}$ pound in 200 feet length of run.

In order to secure the benefit of a sealed return, a "false water-line," so called, is established by the use of a water-line trap. This consists of a constant discharge float trap of large size, mounted at such an elevation as may be necessary to produce the desired depth of water-seal.

The return pipe should be brought into the bottom of the trap instead of the top as is usually the case, and a balance pipe for equalizing the pressure connected with the top.

This pipe should be, if possible, not less than 15 or 20 feet in length and provided with a globe valve near its connection with the heating main.

The reason for this is to allow the space above the water in the trap to become filled with air, after which the valve may be opened just enough to allow the steam pressure to act upon the air cushion in the trap without driving it out. If the steam is allowed to enter the trap, its contact with the cooler return water will cause a rapid condensation, thus producing a partial vacuum within the trap which will often result in draining the entire system of sealed returns, and causing at the same time violent surging and water hammer.

Fig. 1 shows a Curtis trap con-

nected up for use as a water-line trap.

The general method of making the main supply and return connections for an exhaust steam heating system are shown in Fig. 2.

When it becomes necessary to connect an old heating system having small or poorly graded mains and returns with a power plant, different methods must be resorted to, as pressures of 10 pounds or more are often required to produce proper circulation in the coldest weather.

Under these circumstances it is generally necessary to employ one of the so-called vacuum systems by means of which a good circulation of steam can be produced without raising the back pressure on the engine at all,

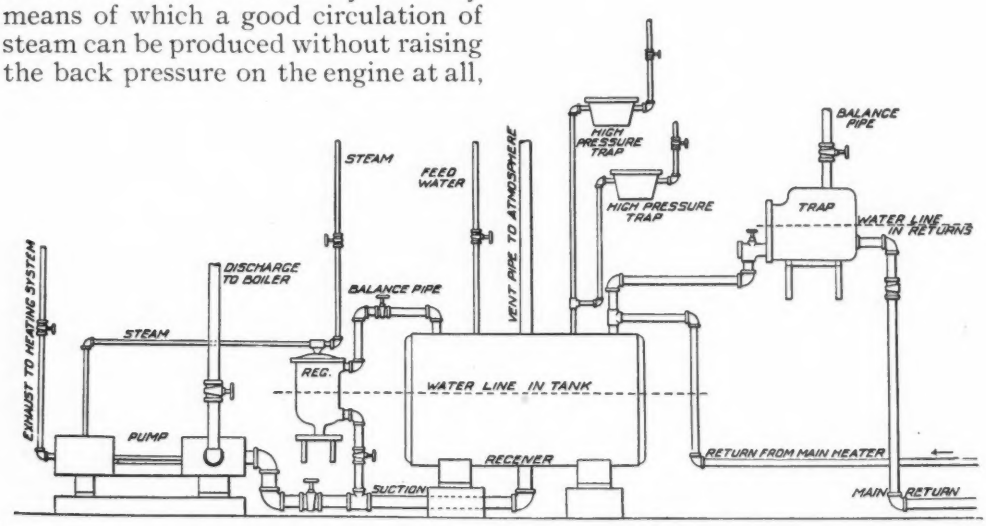



FIG. 2. GENERAL METHOD OF MAKING THE MAIN SUPPLY AND RETURN CONNECTIONS FOR AN EXHAUST STEAM HEATING SYSTEM

and in many cases the pressure may even be reduced below that of the atmosphere.

One point to be borne in mind in the design of any steam plant, is its simplicity; and, when mechanical appliances such as pumps, traps, automatic valves, etc., can be dispensed with without interfering with the proper working of a plant, this should be done.

With properly proportioned and well-graded pipes, the pressure required for circulating the steam through a heating system, even of large size, should not exceed 2 pounds. Now, the back pressure of an engine exhausting into the atmosphere is usually about two pounds, so that practically no additional load is put upon the engine when the exhaust is used in a well-designed heating system; the system simply acts as a large condenser in which condensation takes place under a slight pressure instead of in a vacuum.

We find the increase in boiler pressure required to raise the back pressure from 2 pounds to 5 pounds is only 5 pounds, an amount so small that it can involve no harmful or wasteful results. So far as the efficiency of the radiators is concerned, it makes no difference whether the air is drawn out or forced out, provided that the radiators are steam-filled; and, as the temperature increases with the steam pressure, the heating capacity of a radiator filled with steam under pressure is slightly greater than when steam below atmospheric pressure is used.

Under the pressure system, air valves that are poorly constructed or not well-adjusted, may prevent the radiators from freeing themselves of air. Vacuum systems, on the other hand, employ these or similar devices. It is as necessary in one case as in the other, that the valves be properly adjusted and cared for.

The vacuum system has a large field of its own, and is of much value

in cases calling for the special features that it possesses. In modern plants with pipes of ample size, however, it would seem preferable to rely, as far as possible, upon steam pressure for removing air from radiators, and upon gravity for returning the condensation to the receiving tank, rather than to install special mechanical means for accomplishing the same results.

# The Schoolhouse—Its Heating and Ventilation

By Joseph A. Moore,
Inspector of Public Buildings, State of Massachusetts

## Boilers

## VII

(*This Series of Articles Commenced in Our April, 1906, Number*)

A pound of coal when properly burned gives from 13,000 to 14,000 B. T. U. In actual practice, however, only 40 to 50 per cent. of this is obtainable as effective in furnaces.

In good mill practice one pound of coal, when well burned, will give from 8,000 to 9,000 B. T. U., and 12 pounds of hard coal burned per hour per square foot of grate surface is considered ordinary practice.

In schoolhouses and public buildings about nine pounds of hard coal burned per hour per foot of grate surface may be considered the maximum, while six pounds is about the average; in some cases it is as low as four pounds.

Different heating and ventilating engineers vary as to the amount of air that can be raised one degree F. by one B. T. U., the amount ranging from 48 to 59 cubic feet. A safe rule, however, is to consider one B. T. U. as capable of raising 50 cubic feet of air one degree F.

### SIZE OF GRATE

The size of grate is an important matter. It is seldom advisable to make a grate more than six feet long. When longer, the rear part is liable to be neglected, or the door left open long enough to produce a loss of heat by the large amount of air admitted, and also possibly causing an injury to the fire sheets.

The grate should be equal in width to the diameter of the boiler, and with its area made up as much as possible by width rather than length.

The ratio of grate surface to heating surface usual in different classes of boilers may be considered as follows:

RATE OF GRATE SURFACE TO HEATING SURFACE IN DIFFERENT TYPES OF BOILERS

| Type of Boiler. | Grate Surface. | Heating Surface. |
|---|---|---|
| Horizontal tubular, burning soft coal..... | 1 | 40 to 45 |
| Horizontal tubular, burning hard coal..... | 1 | 30 to 35 |
| Upright tubular, burning soft coal..... | 1 | 35 |
| Upright tubular, burning hard coal..... | 1 | 30 |
| Water-tube, burning soft coal..... | 1 | 50 to 60 |
| Water-tube, burning hard coal..... | 1 | 35 to 40 |
| Locomotive, burning soft coal..... | 1 | 35 to 60 |

In cast-iron boilers it will vary from 1 to 30 down to 1 to 10, according to the design of the boiler.

In schoolhouse work, with horizontal multitubular boilers burning soft coal, 1 to 35 may be considered safe practice; with hard coal 1 to 30.

The relation that the size of the tube bears to the grate surface, and also the number of tubes, have considerable influence upon the economy of a boiler. With different coals a different tube opening is necessary. On account of the large volume of gases which are generated in burning a pound of soft coal, a larger flue area is needed to carry them off and prevent the draft being choked. With hard coal a less volume of gas is produced and a smaller flue area is required.

The ratio of the grate to the combined area of the tube openings may be fixed as follows:

RATIO OF GRATE TO COMBINED AREA OF TUBE OPENINGS

| Type of Boiler. | Area of Grate. | Area of Tube Opening. |
|---|---|---|
| Horizontal tubular, burning soft coal..... | 7 | 1 |
| Horizontal tubular, burning hard coal..... | 9 | 1 |
| Upright..... | 7 | 1 |

For horizontal tubular boilers up to 48 inches in diameter it is advisable to use tubes 2½ inches diameter; from 48 to 60 inches, 3-inch tubes; from 60 to 72 inches, 3½-inch tubes.

When figuring the heating surface of a horizontal tubular boiler the inside area of the tubes should be taken and not the outside, as with a water-tube boiler.

That part of the shell of a boiler over the fire is the most effective, and probably three-eighths of the heat enters the boiler there. If the fuel burns with a long flame, passing the whole length of the boiler, the whole lower part of the shell will receive heat by radiation from the flame, but if there is no flame, but only a mass of heated gas, then the shell back of the bridge wall is less efficient, and only receives heat by the contact of the heated gases.

Some boiler makers and engineers add the heating surface of both heads of the boiler. This gives a somewhat larger commercial horse-power; but as the front head of the boiler receives very little heat from the escaping gases, it is safer to omit that head from the calculation. If the rear head is included only the actual heating surface exposed to the hot gases should be taken, and the area of the tube openings should be deducted from the exposed area of the head of the boiler.

In designing a boiler, after having found the weight of the water to be evaporated per hour or the amount of steam to be condensed, it will be necessary to find how many pounds of coal this will require to be burned per hour.

In power boilers it may be assumed that one pound of coal will evaporate from 9 to 10 pounds of water. Dividing the amount of water to be evaporated by 9 will give the pounds of coal required to be burned per hour.

Dividing the number of pounds of coal burned per hour by the number of pounds of coal burned per hour per foot of grate surface, which may be assumed as 12, will give the number of square feet of grate surface, and from this the size of the boiler can be determined.

In ordinary low-pressure systems of heating in schoolhouses it is not safe to figure as large a number of pounds of coal burned per hour, or as small a grate surface.

When the plant is poorly managed, as it sometimes is by the ordinary janitor, it is safer to estimate the amount of water evaporated by one pound of coal as not exceeding eight pounds, and the amount of hard coal burned per hour per foot of grate surface as six pounds, or even less. On this basis the grate area would be larger.

The amount of air space in a grate must be considered. If this is too small a stronger draft is required than where it is of sufficient size to allow the passage of a sufficient quantity of air when the fire is packed with ashes or clinkers, as is frequently the case near the close of the school day.

The material generally used for the shells and heads of steam boilers is the best quality of open-hearth steel, having a tensile strength of not less than 55,000 pounds or more than 60,000 pounds per square inch, and an elongation of not less than 25 per cent. nor more than 30 per cent. in a length of 8 inches; fire-box steel being used for shell plates, and flange steel for heads.

The tubes should be of the best American manufacture and the braces and stay-bolts of the best refined iron rivets of the best quality. As far as practicable the manhole frames should

be of pressed steel and the nozzles of cast-steel; the lugs, fronts, bonnets, doors and other castings of cast-iron adapted to meet the requirements of the particular parts. The edges of shell plates are planed, and the riveted joints for the most part are calked by a pneumatic calking tool.

The circumference seams are lapped and single riveted. For boilers less than 60 inches in diameter the longitudinal seams are lapped and double riveted. Rivet holes are drilled and the riveting done with a hydraulic riveter, except necessary hand-riveting.

The drift-pin should be used as little as possible.

For boilers 60 inches or more in diameter the longitudinal seams are secured by the triple-riveted butt joint, the edges of the plate being brought together end to end, with a covering plate above and below, and riveted through the three sheets.

Where a boiler is designed for power or high pressure it is much better and safer to use the triple-riveted butt joint than to use the lap joint.

In return tubular boilers less than 60 inches in diameter diagonal braces are used, one end of each being riveted to the shell, and the other bolted to a tee-bar,which is riveted to the shell, the tee-bars being laid out radially.

When the diameter is 60 inches or over, through bolts are used, running from head to head, with two nuts on each end, one inside and one outside the plate. Where the bolts pass through the plate the head is stiffened by channel-iron bars, one continuous bar being used for each horizontal row of bolts. Sometimes a combination of through bolts and diagonal bracing is used. The heads of the tubes are beaded over at both ends and secured by a roller expander, The holes in the plate for the tubes are drilled, the edges reamed, and the corners chamfered off. Where small pipes are attached to the outside shell the metal is thickened by reinforcing plates secured by rivets.

For main connections of steam-pipes and safety valve, nozzles are riveted to the shell, the face of the outer flange being turned, and the flange drilled to receive the bolts.

The manhole frames are inside the opening of the shell. The manhole plate and yoke are of steel, and the joint packed with a lead or rubber gasket.

Steam domes are not commonly used on Massachusetts schoolhouse boilers, as with good construction and proper management of the boilers the steam is found to be quite as dry without as with them. Mud drums are only used in exceptional cases.

In Massachusetts the use of a locked pop safety-valve, set to blow off at fifteen pounds, and of a pattern approved by the Chief of the District Police, will allow a boiler that is used exclusively for heating purposes to be operated without employing a licensed engineer or fireman.

Better service and results will be obtained if a licensed engineer or fireman is employed in addition to having the locked pop safety valve.

An insurance policy in some standard boiler insurance company for $400 for one year is generally furnished by the boiler maker.

Horizontal multitubular return flue boilers are usually made for diameters from 24 to 36 inches with 5-16-inch shell and $\frac{3}{8}$-inch heads; for 54-inch diameters 11-32-inch shell and $\frac{3}{8}$-inch heads. These are for 100 pounds working pressure per square inch.

For 60 inches diameter, boilers generally have $\frac{3}{8}$-inch shell and $\frac{1}{2}$-inch heads, and for 66 to 72 inches diameter 7-16-inch shell and $\frac{1}{2}$-inch heads, for a working pressure of 125 pounds per square inch.

The thickness of boiler plates within ordinary use makes but little difference in the ability of the plate to conduct heat.

A coating or incrustation on the plates and tubes makes considerable difference in the efficiency and life of a boiler and should be carefully guarded against. This is a matter that is often badly neglected by janitors in school buildings.

The setting of a boiler is a matter to be carefully attended to in order that cracks may not appear and allow air

to enter and cool the temperature of the fire and gases in the furnace.

In setting a boiler on marshy or filled ground especial care should be taken to secure a good foundation, and in some cases a thick foundation of good concrete should be put under the whole apparatus to prevent unequal settling and cracking of the walls.

Before a boiler is set the nature of the ground should be carefully investigated.

In setting the fire-brick in a furnace they should be laid with but a small quantity of fire-clay between them, but sufficient to level the work.

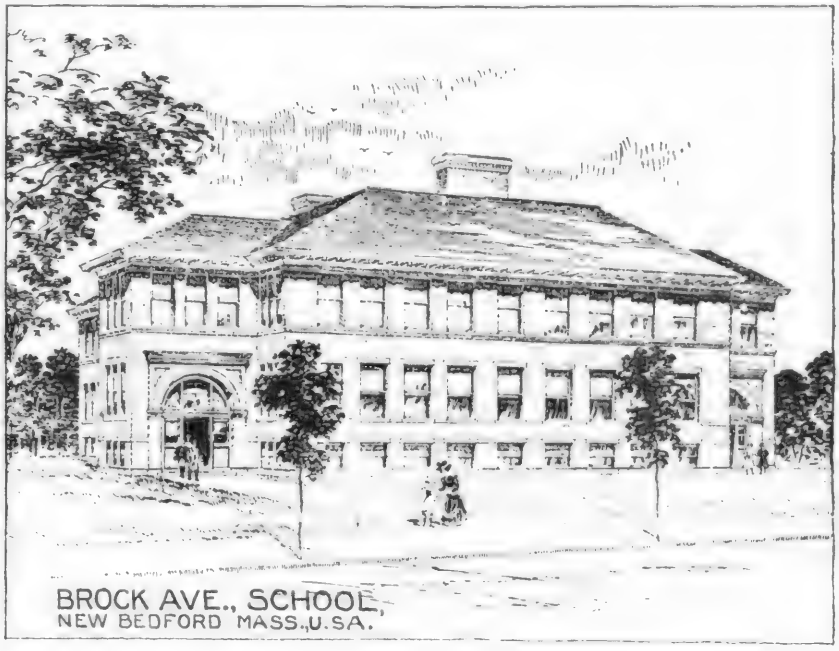
SMOKE FLUES FOR STEAM BOILERS

The smoke flues connecting steam boilers to the chimney should be constructed of iron; brick ones do not prove satisfactory.

In most smoke-flue work No. 12 tank iron is used unless otherwise specified.

The two kinds generally used are those of circular cross-section and those of a rectangular shape.

The seams of circular flues are lap riveted, and the rectangular ones are joined together at the corners by angle irons, and where the flue is of considerable width it is stiffened by the same means. The short branch flue which connects immediately to the boiler (the uptake in a horizontal boiler) is provided with a damper. The main flue between the last boiler and the chimney is fitted with a regulating damper for controlling the entire battery of boilers. The size of the flue should be equal to the collective area of the tube openings in all the boilers to which it is connected. A clean-out which can be closed air-tight should be provided.




BROCK AVENUE SCHOOL, NEW BEDFORD, MASS.

Flues should be as short and straight as practicable, and where a change of direction is made it should be by a curve rather than a sharp or square angle.

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The accompanying plans are those for an eight-room schoolhouse at New Bedford, Mass. This is a two-story building constructed of red brick with granite trimmings.

It contains eight class rooms and two teachers' rooms, also wide corridors and vestibules. In the basement are located play rooms and sanitary rooms for the pupils, a room

for the janitor, boiler and fuel rooms, together with fresh-air chambers and the indirect steam-heating radiators and boilers.

The class rooms are intended to accommodate 49 pupils and teacher, a total of 50. They are well lighted, the pupils' seats and desks being so placed that the light is received from the left and rear.

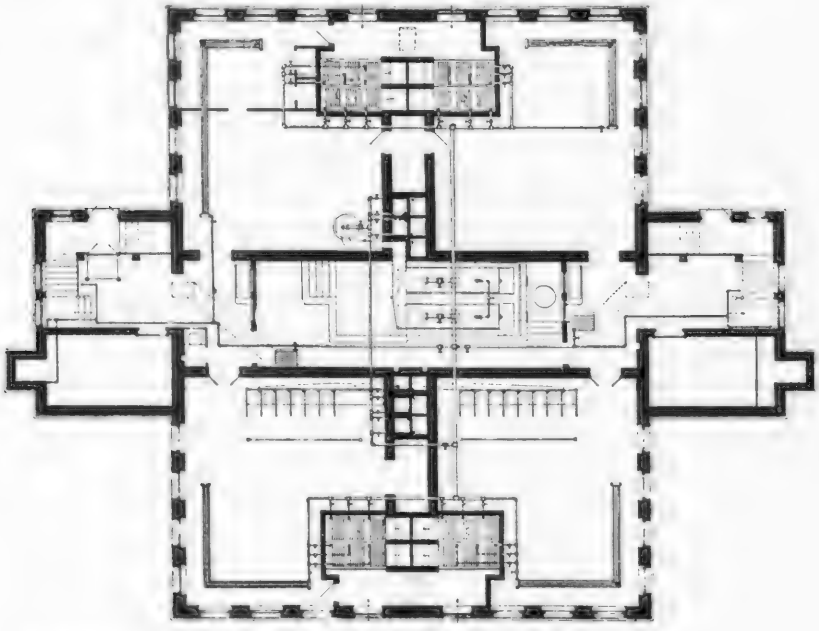
The teachers' rooms in the second story are provided with heating radiators and toilet closets.

The corridors are wide and well lighted, there being glass in the transoms over the doors and a large panel of heavy glass in each door leading from the class rooms.

The conductors, gutters and flashings are of rolled copper. The inside finish of the first and second stories is of selected red oak, and the floors double, the upper floors being of the best rift yellow pine, not over three inches wide.

In each corridor are clothes rails with bronzed hooks for holding the pupils' clothing.

Electric call-bells and speaking-tubes are provided from each class room to the principal's room, also to the janitor's room, and from the main entrance to the janitor's room.



'BASEMENT PLAN BROCK AVE., SCHOOL. NEW BEDFORD, MASS., U.S.A.

The walls of the corridors, staircase wings and vestibules are faced with selected smooth-cut brick. The vestibule floors are of tiles.

The basement floor is of concrete, well rolled and smooth. The plastering is of Windsor cement, and steel lathing is used on ceilings and wooden partitions. The plastering on the brick walls is laid directly on the brick.

The partitions around the stairways are provided with fire stops, as required by the Massachusetts building regulations.

The sanitary closets and urinals in the basement are provided with automatic flushing tanks, and are well trapped and well ventilated into a special vent-flue which contains steam pipes, to cause an outflow of foul air from the basement rooms and sanitary fixtures.

In the first and second story is a galvanized iron stand-pipe and 50 feet of hose for use in case of fire Suitable hose racks are provided.

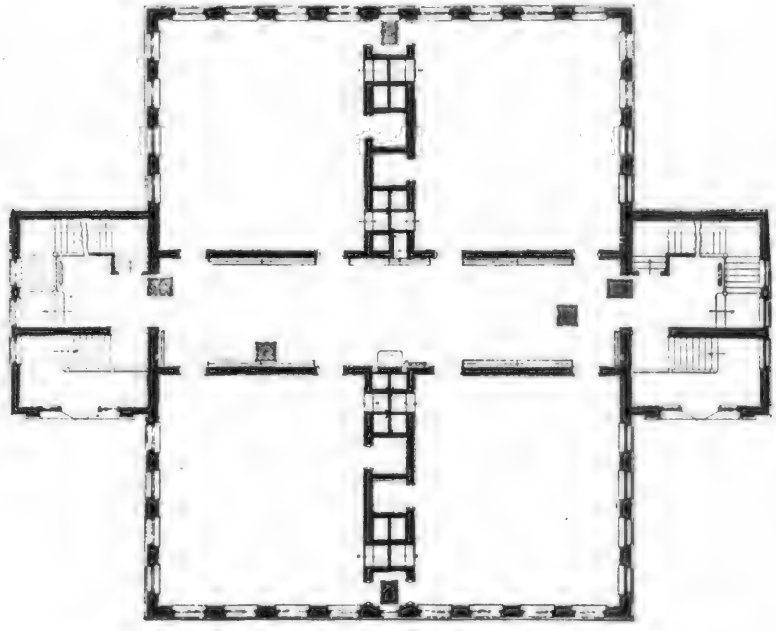
In the basement, corridors and teachers' rooms are water faucets and basins or bowls well trapped.

Two horizontal tubular boilers are provided for heating the building,

each being 42 inches in diameter, 14 feet long, having 38 tubes three inches in diameter and 13 feet long. Each boiler is rated at 32 horse-power and tested to 150 pounds under hydraulic pressure.

Safety valves, automatic damper-regulator, steam gauges, water gauges, fusible plugs, blow-off cocks and all required valves are provided.

A supplementary sectional boiler of the rated capacity of 400 square feet is also provided for the vent-shaft heaters and for use in mild weather in the place of the main heating boilers.



FIRST FLOOR PLAN. BROCK AVE., SCHOOL, NEW BEDFORD, MASS., U.S.A.

The piping for the vent-shaft heaters is so arranged that either or both main boilers or the sectional boiler may be used as desired. The piping in the building is what is known as the two-pipe system, with supply and return for each radiator or coil, and so adjusted that water-hammer or snapping is prevented during the circulation of the steam, and suitable allowance is made for expansion and contraction. The return pipes are not shown on the drawings, but generally follow the line of the supply pipes.

Valves are provided by which part or the whole of the heating radiators may be used as desired. The fresh air for each class room is warmed by being passed through cast-iron indirect radiators in the basement. Four hundred square feet of indirect radiation is provided for each class-room, and is divided into three sections or stacks, so that a part or the whole may be used as desired.

In the teachers' rooms and corridors are direct radiators, and in the basement are lines of steam pipes overhead. Radiators are also provided for bringing warm air up through two registers in the floor of the first-story corridor, the air being rotated from the corridor floor near the stairway extensions. These are designated as foot-warmers, and enable the pupils to warm their feet and hands and dry their clothing in cold, stormy weather.

In the floor of the closets between the class rooms in the first story are what are termed rotating registers, for use at night or when the rooms are not in use. The windows in the cold-air rooms and the dampers in the vent-flues being closed, the rotating registers are opened and air is drawn down from the class rooms, passes through the indirect radiators

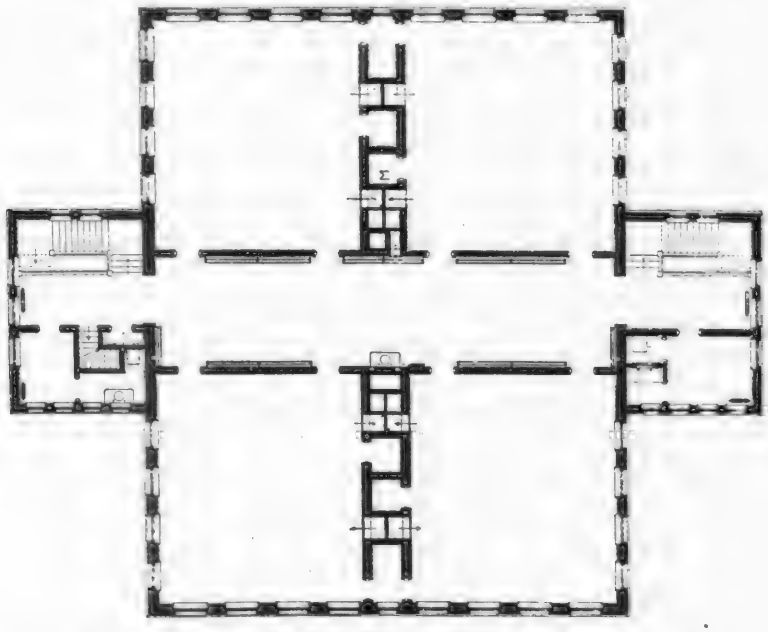
and is returned to the class rooms through the warm-air flues, thereby keeping the rooms warm.

The warm fresh air is brought into the class rooms through openings eight feet above the floor as shown in the drawings, and the vitiated air is removed through openings at the floor level, located as shown in the plans. The warm-air and foul-air flues are of brick, and well smoothed up on the inside.

Each foul-air flue contains 20 square feet of steam pipe heating surface for causing an outward flow of vitiated air, and is also provided with warmers consist of 100 square feet each of cast-iron radiators.

At an inspection of this building the following conditions were found:

Weather, fair; wind, north and moderate; outside temperature, 21 degrees F.; outside relative humidity, 57 per cent.; barometer, 30.32; average temperature of air at inlets to class rooms, 87.1 degrees F.; average supply of fresh air through inlet to each class room, in cubic feet per minute, 2,337; average amount of air removed at outlet from each class room, in cubic feet per minute, 2,984; average amount of air, in



SECOND FLOOR PLAN. BROCK AVE., SCHOOL, NEW BEDFORD, MASS., U.S.A.

a curved damper of galvanized iron, operated by a chain and catch, by which the amount of air taken from the rooms can be regulated or shut off when the rooms are not in use. In each warm-air flue is a galvanized-iron mixing valve.

The direct radiation consists of vertical loop cast-iron radiators of an aggregate of 325 square feet of surface in corridors and teachers' rooms, and 280 square feet of surface of 1½-inch steam pipe in coils overhead, in the basement.

The indirect radiators for the foot-

cubic feet per minute, supplied at inlet for seating capacity of each class room, 47.7; average amount of air, in cubic feet per minute, removed through outlet in class rooms, for each pupil, 60.9; greatest amount of air, in cubic feet per minute, supplied at inlet to any class room, 3,247; least amount, 1,730 cubic feet; average difference in temperature in any room, taken at the same time at four places, at the breathing plane, 2 degrees F.; least difference at same points, 5 degrees F.; average temperature at teachers' desks, 69.5 degrees F.

# Ventilation of the Boston Subway*

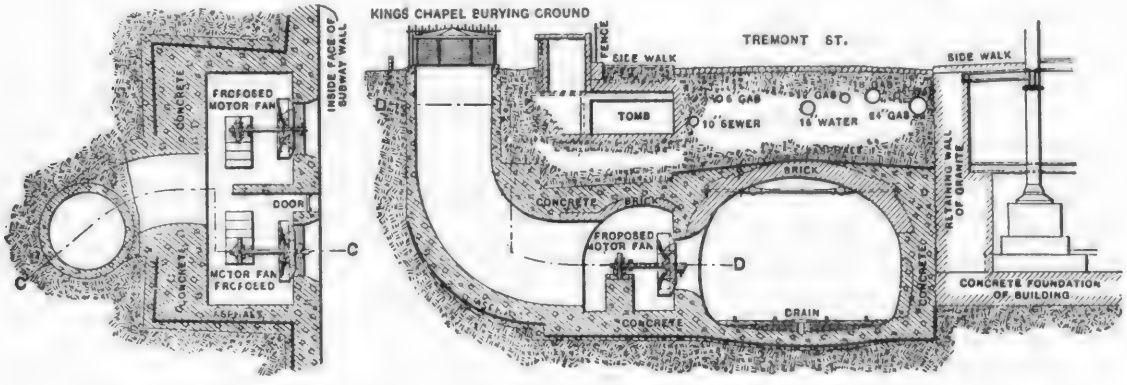
By Howard A. Carson, Boston, Mass.

The aggregate length of the Boston Subway system is about 3½ miles and may be conveniently divided, for purposes of description, into the original subway, the East Boston tunnel, and the Washington street tunnel. Most of the subway system is for two tracks, but a portion of the original subway is for four tracks.

The original subway and the East Boston tunnel were intended for surface electric cars running singly, but two of the tracks in the subway have been for some years used for trains, contrary to the former wishes of the Transit Commission. The Washington street tunnel is intended solely for trains, and on its completion the trains will be taken from the original subway and the subway be restored to its former use, i. e., for surface cars run singly.

The general scheme of ventilation in all parts of the system is that fresh air shall enter at the stations or portals and be drawn out from what may be called the traffic tubes at points midway between the passenger stations. Owing to the respective environments of (1) the original subway, (2) the East Boston tunnel and (3) the Washington street tunnel, the conduction of the air after leaving the traffic tubes in these three divisions varies. Some description and illustration of the methods adopted in the ventilation of these divisions will presently be given. Before doing so, however, it may be well to give some indication of the density of passenger traffic. Some idea of this may be had by examining the following figures regarding total number of passengers per annum, going and coming, at the most important station of the original subway and at eight important steam railroad passenger stations, as taken from the report of the Transit Commission for the year ending August 15, 1899:

| Station. | Number Passengers. |
|---|---|
| St. Louis Union Station, St. Louis | 8,000,000 |
| Grand Central Station, New York City | 14,000,000 |
| South Union Station, Boston | 21,000,000 |
| North Union Station, Boston | 23,108,384 |
| Broad street Station of North London Railway | 27,000 000 |
| Park street Station of the Boston Subway | 27,400,000 |
| Waterloo Station, London (1898) | 28,659,118 |
| St. Lazare Station of the Chemin de fer de l'Ouest, Paris | 43,062,688 |
| Liverpool street Station of the Great Eastern Railroad, London | 44,377,000 |




Section on Line D-D Section on Line C-C

FIG. 1. TWO TRACK SUBWAY AND VENTILATING CHAMBER NORTH OF SCHOOL STREET, BOSTON

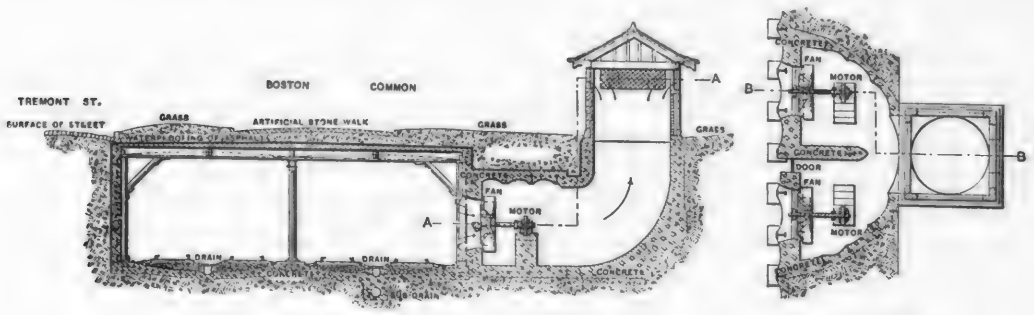
The Park street station figures are based on the traffic during the eleven months ending August 15, 1899 (before the introduction of trains), and are estimated from the sale of tickets and from other observations.

It was estimated that at least 50,000,000 passengers used the original subway during the first 12 months after its completion. Its use has apparently increased since then over 60 per cent.

### VENTILATION OF THE ORIGINAL SUBWAY

In the original subway there are ventilating chambers placed at the side of the tunnel, midway between each pair of stations, and exhaust fans are set in circular openings in the walls that separate the chamber from the traffic tubes. The air which enters at the stations is drawn by the fans from the tunnel and

*From a paper presented at the December, 1906, meeting of the American Society of Mechanical Engineers and forming part of Vol. 28 of the transactions.




Section on Line B-B Section on Line A-A

FIG. 2. FOUR TRACK SUBWAY AND VENTILATING CHAMBER NEAR WEST STREET, BOSTON

discharged vertically from the chambers, in some cases through grated areas in the street sidewalks and in other cases through low shafts. Some details concerning two of these ventilating sections, which will serve to illustrate the method of ventilating the original subway, follow:

The section between the Park street station and the Boylston street station is 4-tracked, its interior width being 48 feet and its height from the base of the rails to the under side of the roof 14 feet 8 inches. The distance between the centers of the stations is about 1,250 feet. The ventilating chamber for this section is under Boston Common, nearly opposite West street and midway between the stations. (Figs. 1 and 2.)

A low stone building serves as a shaft, over the chamber. This section is ventilated by two fans, each having a diameter of eight feet and a rated speed of

FIG. 3. INCONSPICUOUS SHAFT OVER VENTILATING CHAMBER

about 175 r. p. m. The rated delivery of each fan is 37,000 cubic feet per minute.

The section between Park street and Scollay square is double tracked, its interior width being 23 feet and its clear height, from the base of the rails to the tie-rods, 14 feet 8 inches. The distance between the centers of the station is 1,450 feet. The ventilating chamber is situated under the King's Chapel burying ground, to the north or midway between the two stations. (Fig. 3.) The two fans which serve this section are 7 feet in diameter and have a rated capacity of 24,000 cubic feet per minute each and 220 r. p. m. With rates as stated, the air would be changed in these sections about once in ten minutes. The stated frequency of change is six times as great as that reported to have been provided for in the most recent London subway, the Baker Street and Waterloo Railway.

FIG. 4. GRATED OUTLET OVER VENTILATING CHAMBER

A photograph of a grated outlet over the ventilating chamber at the corner of Washington and Hanover streets is shown in Fig. 4. An inspection of this photograph indicates an obvious objection to an outlet of this class.

VENTILATION OF THE EAST BOSTON TUNNEL

The general scheme of taking in fresh air at the stations and portals and discharging from the traffic tubes at midway points is observed in the East Boston tunnel. But as it was, of course, not practicable to discharge directly into the outer air from the middle of the harbor, provision was made to conduct the vitiated air to the shores.

The duct used in ventilating the harbor portion of the tunnel extends from near Webster street in East Boston to and under the harbor and to the Atlantic avenue station. The duct (Fig. 5) has a cross-section of about 48 square feet, and is formed in the upper part of the tunnel by means of a diaphragm, one inch thick, made of expanded metal enclosed in cement mortar. This diaphragm is attached to the tunnel walls by steel rods and plates which are themselves encased in concrete. A partition midway between its two ends divides the duct into an easterly and a westerly portion. Immediately on each side of the partition there are 14 openings, each 4 feet long and 1 foot 5 inches wide, through the flat portion of the cross-section of the duct; and at intervals of about 550 feet there are other groups of openings, diminishing in number as they approach the fan chambers. These openings are fitted with doors which can be opened or closed from the tunnel below. When the movement of the air in the tunnel is not affected by wind only the two groups of openings close to the middle partition are kept open. When, however, the movement of the air is so affected, the various openings should be used in such a manner as to best promote the even ventilation of the different parts of the tunnel.

Fresh air enters the tunnel from the portal at East Boston and also from and through the station near Atlantic avenue, distant about one mile from the portal. This air moves to near the middle of the tunnel under the harbor and passes through the openings into the duct referred to above. The air is then drawn to the east and west and leaves the tunnel at the fan chambers at Lewis street in East Boston and at Atlantic avenue, respectively. A diagram rudely indicating the movement of the air is given in Fig. 6.

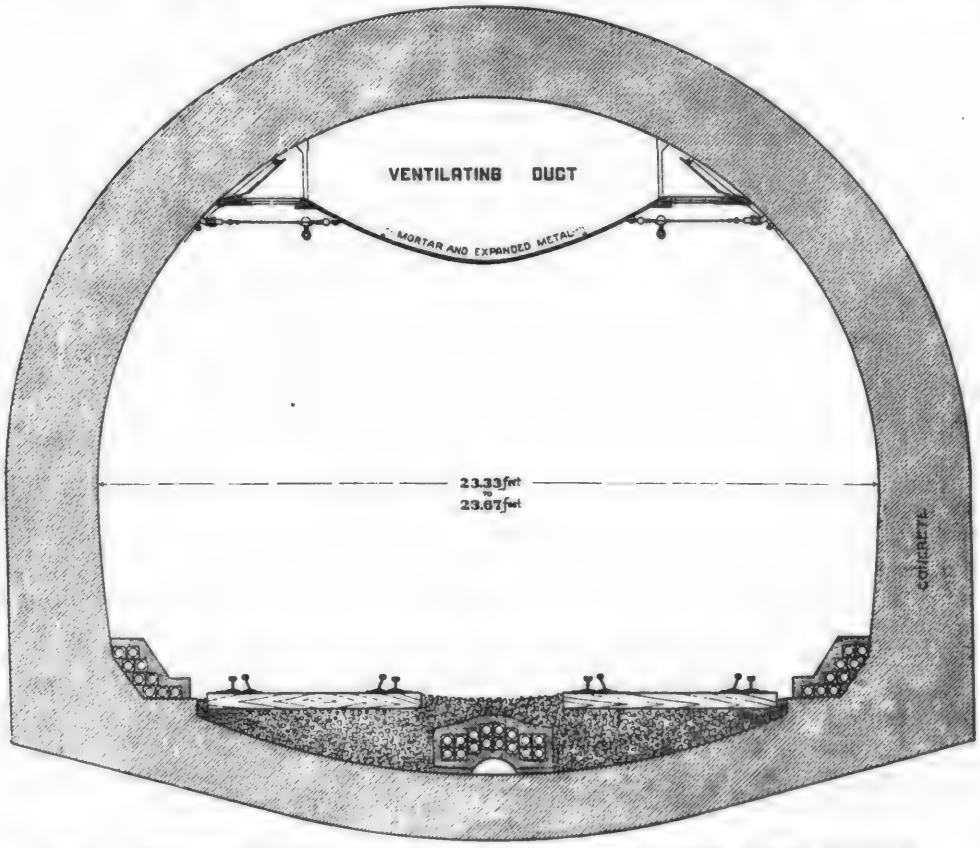



FIG. 5. CROSS-SECTION OF THE EAST BOSTON TUNNEL UNDER THE HARBOR

In the East Boston chamber the air leaves through a grated area 40 feet long and 7 feet 1 inch wide, in the sidewalk. It is intended that the air shall not pass through any part of the gratings of this and other sidewalk outlets at a velocity greater than 3 miles per hour.

From the Atlantic avenue chamber the air passes into a divided duct carried up at one end of the passenger station and is discharged 21 feet above the surface of the street.

The ventilating apparatus at the East Boston chamber consists of two single-inlet 8-ft. vertical fans having for normal and maximum speeds, respectively, 175 and 185 r. p. m. and at the Atlantic avenue chamber, two double-inlet 7-ft. horizontal fans with speeds of 205 and 218 r. p. m. At the maximum speeds stated the two fans in each chamber, with an input of about 12 horse power to each fan motor, will together exhaust 45,000 cubic feet of air per minute—90,000 cubic feet for the two chambers.

This quantity will give an air velocity in the tunnel of nearly 2½ feet per second and will change the air in the section of the tunnel under the harbor every 15 minutes. Smaller air deliveries can be obtained by running the fans at lower speeds or by running one fan at a time in each chamber.

The portion of the East Boston tunnel between the Atlantic avenue station referred to above and Scollay square—the westerly end of the tunnel—is ventilated by means of fans placed in horizontal openings over the roof of the subway and the air is discharged through a chamber connecting with a grated opening in the sidewalk, nearly opposite the Custom House. The two fans, with an input of about 3½ horse power to each fan motor, will each exhaust 20,000 cubic feet of air per minute, which will give an air velocity in the tunnel, toward this centrally placed chamber of one foot per second and change the air in 1,600 feet length of tunnel in 13 minutes.

THE WASHINGTON STREET TUNNEL

As in the original subway and in the East Boston tunnel, fresh air is to be admitted at the stations and portals and withdrawn from the traffic tube at about midway points. It is not in general practicable to discharge the vitiated air directly into the outer air at the points where it is taken from the traffic tubes; nor is it practicable to discharge through grated areas in the sidewalks, the latter during the day being densely crowded. Air admitted at the portals and at the station entrances and leaving the tunnel at intermediate points will pass thence through specially constructed ducts—in some cases underneath and in others above the tunnel—having a minimum cross-sectional area of about 40 square feet and a length of from 270 feet to 430 feet, to fan chambers. There will be room in each chamber for two single-inlet centrifugal fans, each with a capacity of 20,000 cubic feet or more per minute, giving an average velocity of air in the tunnel of upwards of one foot per second, equivalent to changing the air in each section, say, three times every hour.

The general movement of the air in the Washington street tunnel is shown in Fig. 7.

For specific illustration we may take the platform at LaGrange and Boylston streets. This is 350 feet long and has 15 feet of breadth of stairway at one end and 18 at the other. Air entering the Boylston street station will reach the platform through a stair and passageway. Turning southerly, it will pass through the tunnel to Eliot street, a distance of about 530 feet from the Boylston street entrance. It will be joined at LaGrange street by a current of air from the entrance and stairway there located and at Eliot street by a northerly current admitted to the tunnel at the southerly portal, 570 feet farther south. At Eliot street the combined volume will pass through openings in the westerly side of the tunnel into a duct below the tunnel invert. This duct, about 370 feet long, will lead the air back, northerly, to and underneath the LaGrange street station, where the air will be extracted by fans and discharged at the back of the station through a shaft having a clear cross-section of 36 square feet and carried to the height of the adjacent buildings.

It may be mentioned here that practically all of the stairways and station entrances and exists on the Washington street tunnel are on what was formerly private property which has been taken by the Transit Commission and that all but one of the fan chambers and exits for so-called soiled air will also be on what was formerly private ground. The one exception is in the middle of Adams square. The discharge in that case will be through a grated opening around the Adams monument.

The following table gives additional details of the courses of the ventilating currents of air at various points in the Washington street tunnel:

AT LaGRANGE STREET STATION

| INLETS FOR FRESH AIR | COURSE OF AIR IN TUNNEL | COURSE OF AIR IN DUCT |
|---|---|---|
| South portal.<br>LaGrange street entrance.<br>Boylston street entrance. | Northerly, from south portal to invert duct inlet at A on Fig. 7; about 570 feet. Southerly, from Boylston street station entrance to A; about 530 feet. | From A, northerly under tunnel invert and westerly under LaGrange street station to fan chamber and chimney at LaGrange street station; about 370 feet. |

AT HAYWARD PLACE STATION

| INLETS FOR FRESH AIR | COURSE OF AIR IN TUNNEL | COURSE OF AIR IN DUCT |
|---|---|---|
| Essex street entrance.<br>Hayward place entrance.<br>Temple place entrance.<br>Winter street entrance. | Northerly, from Essex street station entrance to arch duct inlet at B on Fig. 7; about 650 feet. Southerly, from Winter street station entrance to B; about 650 feet. | From B, southerly under tunnel arch and easterly under Hayward place station, to fan chamber and chimney near Hayward place entrance; about 430 feet. |

AT OLD SOUTH MEETING HOUSE STATION

| INLETS FOR FRESH AIR | COURSE OF AIR IN TUNNEL | COURSE OF AIR IN DUCT |
|---|---|---|
| Summer street entrance.<br>Franklin street entrance.<br>Old South Meeting House entrance.<br>Water street entrance.<br>Old State House entrance. | Northerly, from Summer street station entrance to arch duct inlet at C on Fig. 7; about 550 feet. Southerly, from Old State House station entrance to C; about 900 feet. | From C, northerly under tunnel arch to fan chamber and chimney near Old South Meeting House entrance; about 270 feet. |

AT SURFACE IN ADAMS SQUARE

| INLETS FOR FRESH AIR | COURSE OF AIR IN TUNNEL | |
|---|---|---|
| Old State House entrance.<br>Two entrances between Hanover street and Haymarket square.<br>North portal. | Northerly, from Old State Station entrance to fan chamber and surface grating at D on Fig. 7; about 300 feet. Southerly, from north portal to D; about 1,430 feet. | No duct. |

THE VENTILATION OF ELECTRIC SUBWAYS

Most of the subways hitherto constructed have not been provided with mechanical plants for positive ventilation. The reason of this doubtless is that the air in electrically operated subways without ventilation is, in general, far better than that of steam operated subways that are ventilated.

The following table, comparing the relative vitiation of the air in the subway at a time when the traffic was large and when no fans were running and that in various halls, theaters, churches, schools, etc., appears to justify the omission of positive ventilation in subways.

| Parts of Carbon Dioxide in 10,000 Volumes | |
|---|---|
| Boylston street station, 5 feet above southbound platform | 9.45 |
| Midway between the Boylston street station and the Winthrop school ventilating chamber | 6.53 |
| Park street station, 5 feet above the southbound platform | 7.78 |
| Adams square station, 5 feet above platform | 6.62 |
| Haymarket square station, 5 feet above northbound platform | 9.13 |

Samples taken between 5 and 5.30 p. m., on week days in January and February, 1899. One of the fans in the West street chamber is believed to have been running when the third sample was taken. In the other cases none of the fans were running.

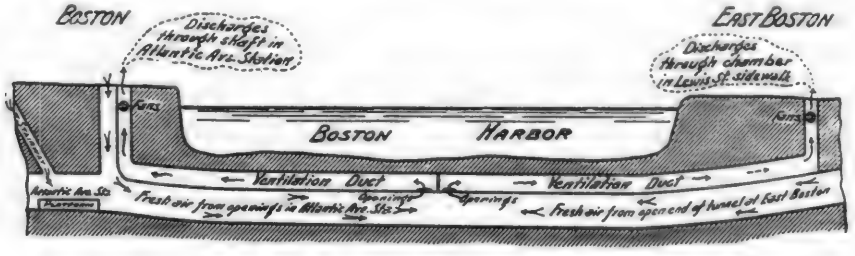



FIG. 6. DIAGRAM (NOT TO SCALE) INDICATING MOVEMENT OF AIR
The Length of Tunnel Indicated is About One Mile

| | |
|---|---|
| On the street in the central part of the city | 4.5 to 5.9 |

Made at about the same time of year.

| | |
|---|---|
| In the center of a car on Boylston street about to enter the subway | 24.97 |

Sample taken about 8.30 a. m., February 25, 1899, and car contained about sixty-five passengers. Rear door was opened once or twice while sample was being taken. Forward ventilator was

FIG. 7. GENERAL MOVEMENT OF AIR IN WASHINGTON STREET TUNNEL

closed and rear ventilator open about one-half inch. Weather clear and cold.

City Hall Council Chamber, two-thirds full.

Floor 10.12 to 14.60. Gallery 13.22 to 18.58.

Large public hall in Boston, near open door, with in-draught..... 13.93

Another hall in Boston, well-filled. 32.59 to 36.43 (the latter being in the gallery).

Four of the principal theaters in Boston.....16.16 to 48.7

Two large churches, Boston and Brookline.....12.45 to 18.19

Twelve schools in Boston, Cambridge, Chelsea, etc.....7.1 to 23.50

The fitness of air in the subway for breathing, however, can probably be better ascertained by means of sensitive noses of persons used to fresh air than by the ordinary methods of chemists. Crowded unventilated subways contain not only carbonic acid and other matters thrown off from human lungs but have also, widely diffused through the air, fine dust from the ballast, fine particles of oil from the machinery, and finely ground particles of iron from the brake shoes. All of these are disagreeable and probably injurious to health.

Another matter, at times perhaps more disagreeable and injurious than either of the foregoing, is that of the rise of temperature in subways caused by the conversion of a large amount of electric energy into heat. As far as the writer is aware, no particular attention had been given to this question until the summer of 1905 after the opening of the New York subway. The most obvious remedy for annoyance caused by the fine dust, iron, and oil, and the rise of temperature referred to, is a judicious use of an ample ventilating system.

### THE COST OF SUBWAY VENTILATION

A very rough estimate for the Boston system places the total cost of the ventilating construction, including chambers, ducts, fans and motors, at $125,000, or less than 1 per cent. of the combined cost of the original subway, the East Boston tunnel, and the Washington street tunnel. An equally rough estimate of the cost of operation, including power, depreciation, attendance, and interest on first cost, for ventilating the combined system is $14,000 per annum. This will probably be less than 1 per cent. of all costs of operation and interest.

The cost does not appear to be prohibitive, and considering experience up to the present time it seems fair to say that electric subways with dense passenger traffic should have the means, and the means should be freely used, for complete positive ventilation.

It may be well in closing to note that if the passengers in the subway are to breathe pure air the cars should be ven-

tilated as well as the subway itself. The seventh observation in the table shows that the air in a car just about to enter the subway contained more than three times as much carbon dioxide as the average air above the station platforms.

## Contributed Discussion—The Ventilation of Boston Subway

MR. CHARLES S. CHURCHILL: The Boston Subway holds the unique position of being the only electrically operated subway in the United States that is efficiently ventilated by mechanical means. The writer, in a paper on the "Ventilation of Tunnels," presented to the International Engineering Congress at St. Louis, in 1904, gave a brief description of the ventilation of the original portions of the Boston Subway; and has more recently referred to the ventilating system of this subway as a model in its careful design and execution during construction.

It may be further stated, after a personal examination of a number of subways in England, France and Germany, that the ventilating system of the Boston Subway is not excelled by them in efficiency. Mr. Carson's paper, therefore, is a very valuable one as furnishing a complete detailed record of a good mechanical ventilation system of an electrically operated subway, and one that can in principle be followed, not only by existing subways not ventilated as they should be by mechanical means, but also in the case of subways to be hereafter constructed.

It should be noted that the ventilation of the recent extension of this subway under Boston Harbor, described as the "East Boston Tunnel," and about one mile in length, is similar in principle to that installed during the construction of the Mersey Tunnel, Liverpool, in 1886, which is about two miles in length, and is now electrically operated. The important difference, however, is that the ventilating duct is carried outside and is entirely independent of the general tunnel section from the center thereof to each end, whereas this duct in the East Boston Tunnel is cut from the tunnel area itself, thereby reducing it 48 square feet, and making it about 20 square feet less in area than the balance of the Boston double tracked sections of subway. It is considered objectionable to reduce the tunnel cross-section in this manner as just so much room for fresh air is lost. Further, the various entrances to the ventilating duct must be opened or closed frequently to suit weather conditions. In a tunnel like this, with an open portal or large opening at one end and a station at the other, not only can the necessity of this reduction be avoided, but also the somewhat indirect handling of fresh air currents, which are interfered with either by passage of cars or by the velocity of the outside air, can be improved. Fresh air may be brought into such a tunnel at the station end without reducing the tunnel section, and from there forced entirely through it at any velocity desired, similar to the plan followed in ventilating some steam railway tunnels, for example, Elkhorn Tunnel on the Norfolk and Western Railway, Big Bend Tunnel on the Chesapeake and Ohio Railway, and Gallitzin Tunnel, on the Pennsylvania Railroad; but the velocity of the fresh air current required in an electric tunnel will be but a small fraction of that required for a steam railroad tunnel.

Mr. Carson, while giving the parts of carbon dioxide ($CO_2$) per 10,000 volumes of air found in various parts of the Boston Subway when the ventilating plant was not in use, unfortunately fails to give the corresponding figures while the plant is in full operation. This information would be an important and valuable addition to the records of the ventilation of subways; and it is to be hoped that this data will be furnished, so that it may be compared with the following observations made by the writer as to the condition of air in the cars of various European subways that are mechanically ventilated.

| NAME OF ELECTRIC SUBWAY | PARTS OF CARBON DIOXIDE PER 10,000 VOLUMES OF AIR IN CARS | PARTS OF CARBON DIOXIDE PER 10,000 VOLUMES AIR OF STREET |
|---|---|---|
| Metropolitan Railway, Paris .. | 2.94 | 1.76 |
| Central London, London..... | 5.92 | 3.55 |
| Great Northern and City Railway, London..... | 2.35 | 1.75 |
| Mersey Tunnel, Liverpool..... | 4.70 | (not taken) |
| City and South London, London (not mechanically ventilated) | 11.78 | 3 55 |

Mr. Carson, after comparing the quality of air found in the Boston Subway when plant was not in operation with that found in some of the halls and schools of Boston, and noting from the comparison that worse air was found in some of the latter than in the subway, makes the suggestion that this condition "appears to justify the omission of positive ventilation in subways." It should be borne in mind, however, that carbon dioxide is not the only factor that makes ventilation necessary. In schools and halls such elements as dust from ballast, oil from machinery, iron dust from brake shoes, and heat from the conversion of large amounts of electric energy, are not present; and these elements

alone may make ventilation of subways necessary.

That Mr. Carson does not regard such an omission as good practice is evidenced by the fact that the Boston Subway has been mechanically ventilated. The writer doubts if any individual or corporation will argue that because bad air is found to exist in poorly designed structures used by the public, therefore, in the construction of modern buildings and subways the same degree of vitiated air is allowable.

There was found a few years ago in certain public halls and council chambers in London air which contained 14.9 parts of carbon dioxide per 10,000 volumes. However, newspapers of London very frequently attack subway companies in case air is allowed to even approach this condition. Further, the Factory Act of England makes 9 parts carbon dioxide ($CO_2$) per 10,000 volumes of air the maximum in rooms, etc., and the report of the London County Council in 1902 places the safe maximum limit of carbon dioxide in the air of any part of a subway at 8 parts per 10,000 volumes of air, and this applies to the cars in the subways.

Inasmuch as a subway car carrying passengers will have 45 per cent. or more or carbon dioxide in excess of that found in the general subway air, this requirement signifies that the general subway air should, for the comfort of the patrons and health of the employees of the subway, be maintained so as to contain not more than about 50 per cent. more carbon dioxide than the outside air. Dust should also be cared for, and the temperature of the subway should be kept within normal limits. These results, as stated by Mr. Carson, cannot be secured in any subway without positive mechanical ventilation such that fresh air is delivered to all parts thereof, and there should be added to his statement: the total furnished by natural and mechanical means should be sufficient to supply about 30 cubic feet of fresh air per minute to each person in the subway.

Mr. Carson very tritely remarks that the sensitive noses of the patrons of a subway readily detect the general quality of subway air. The subway tunnel of the City and South London Railway, which is not mechanically ventilated, and, therefore, is much more heavily charged with carbon dioxide than the ventilated subways of London that carry much heavier traffic, was found by the writer, as well as by others, to have a disagreeable odor. The writer in September of this year, while traversing the Rapid Transit Subway in New York, not only personally made this kind of observation, but noted from the expressions of the faces of passengers in the same car that mental adverse comments on the quality of the subway air were being recorded. It is gratifying to note, however, that steps are evidently being taken for mechanically ventilating the New York Rapid Transit Subway.

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# *Boiler and Setting**

## *Improved Design for Use With Bituminous Coal*

By A. Bement, Chicago, Ill.

Fig. 1 shows an elevation and section of a modified design of boiler equipped with a chain grate stoker, although any other stoker machine would be applicable.

The principal objects to be secured in this design are:

a. The attainment of a perfect and smokeless combustion;

b. The full utilization of the boiler heating surface.

The first requirement is secured by the location of a tile furnace roof, which is supported by the boiler tubes of the lower row. The individual refractory tiles used in the formation of this roof are illustrated in detail in Fig. 2 and by a vertical cross-section, Fig. 3. The effect of the presence of this tile roof is to prevent the flow of unburned gases among the tube surfaces of the boiler, and to insure that they travel a considerable distance before the heating surface is reached, during which time these gases and the air present therewith may become sufficiently mixed together to insure entire combustion. The particular form of stoker shown, that of the chain grate, owing to the fact that the fuel is fed only in a horizontal line, and for which reason sudden and irregular charges of fuel cannot enter the fire, insures the apparatus to be entirely smokeless. It might be styled smokeproof, if this expression is permissible in this connection. When other styles of stoker machines are used under such roof, the attainment of complete combustion is dependent upon careful manipulation of the machine and fire, because the capacity of the tile roof furnace herewith illustrated is only sufficient to properly mix together the air and gases which flow from a chain grate fire. Therefore, in other forms of stokers, it is necessary for the uniformity in feed of coal and condition of fire to be equal to that secured with chain grates for complete combus-

*From a paper presented at the December, 1906, meeting of The American Society of Mechanical Engineers, and forming part of Volume 28 of the Transactions.

tion to be effected. A considerable number of such tile roof furnaces are now in successful operation.

To insure that all of the boiler surface shall be usefully employed the gases are led over the whole portion of it by means of passages of less area than are commonly used. It is the writer's observation that in many boilers various corners and other portions are not acted upon by hot gases, because the decreasing volume due to the gases becoming cooled is not equal to the capacity of the passage, for which reason in this design the additional baffles are employed. The decrease in size of these passages, however, is not in the same ratio as the reduction in volume of gas. Proportioning the passages according to the volume of the gases in the different parts of the boiler would have required at the inlet to the tube surface a space much larger, with the effect of very materially reducing the length of the tile roof. Therefore the compromise illustrated is adopted.

A space at the bottom of the boiler above the tile roof equal to that which would ordinarily be required by the second and third tier of tubes is left vacant for the purpose of accumulating dust, which may be removed through cleaning doors in the side wall of the setting. The lower tubes supporting the tile roof are of 3.5 inches diameter, and of a heavier gage than the 4-inch tubes above. The smaller diameter is employed for the purpose of affording greater space for the necks of the tiles than is obtainable with the 4-inch tubes.

The contracted passages among the tube surfaces of this boiler necessarily produce a high resistance, and for this reason a strong draft is required, and this appears to be true of any boiler when arranged so that all of the heating surface is utilized. According to the author's present conclusions, a combination of forced and induced draft affords means for the production of the best obtainable combustion, particularly so with the chain grate stoker. The induced draft may, of course, be obtained either with fan or chimney. The office of the forced draft is to move the gases as far as the furnace chamber, from which point they flow among the heating surfaces of the boiler to the chimney by

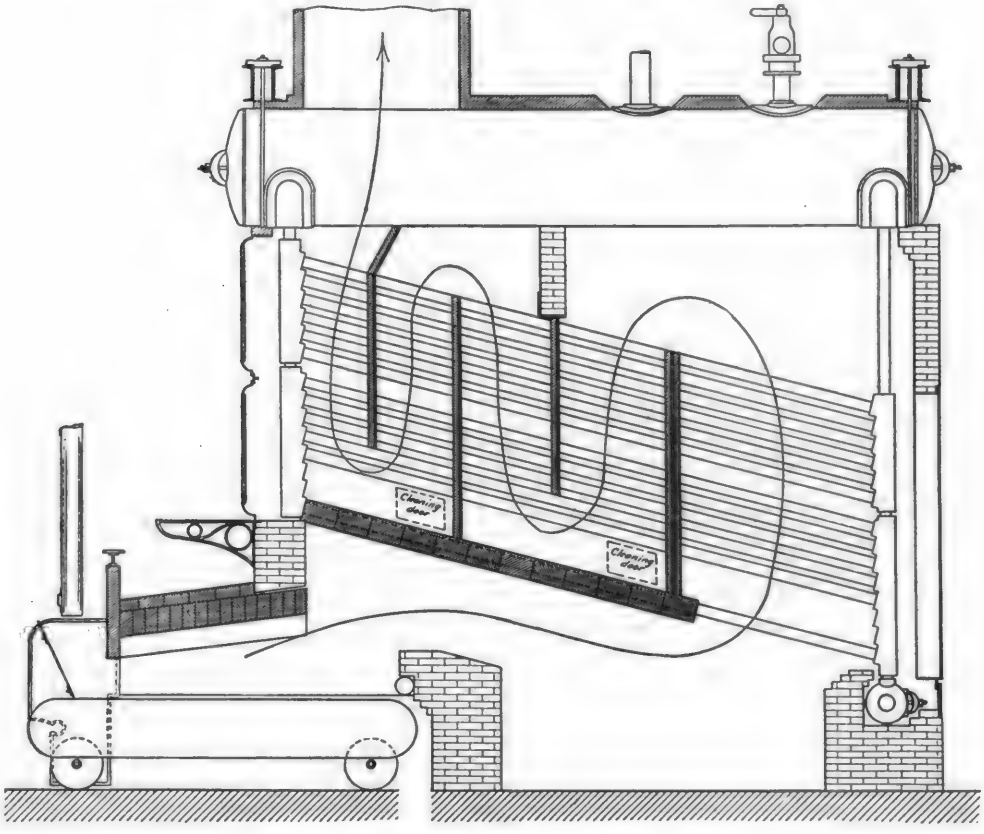


FIG. 1. IMPROVED BOILER AND SETTING

means of the power of induced draft. Therefore, the influence of the forced draft extends from below the grate to the furnace chamber, while the power of the induced draft extends from the chimney among the heating surfaces to the point in the furnace at which that of the forced draft ceases. Under such conditions the pressure of the gases in the furnace is the same as that of the atmosphere. This prevents a portion of the air leakage, which, under other conditions, would flow into the furnace chamber by way of openings at the stoker through the brick walls and elsewhere. By manipulating the intensity of the forced and induced draft, a balance pressure may be obtained in the furnace chamber when varying amounts of coal are being burned. Therefore, this draft

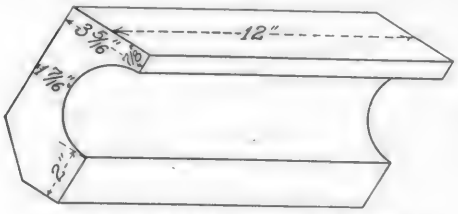


FIG. 2. REFRACTORY TILE FOR FURNACE ROOF

system operates not only to overcome the resistance due to the passage among the heating surfaces, but also insures complete combustion with a smaller air supply than would be the case with induced draft alone. This condition has been referred to as that of balanced draft. In this connection it may be well to call attention to the fact that forced draft cannot be depended upon to compel the flow of gases among the heating surfaces to any great extent, because when the pressure in the furnace chamber becomes greater than that of the atmosphere, the flames and fire will blow out through the doors, cracks, or other openings.

Figures are as yet not available, showing the exact effect of this particular ar-

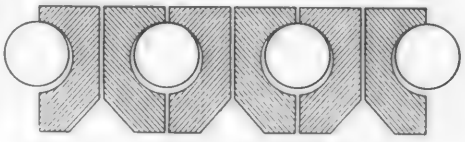

FIG. 3. SECTION SHOWING FURNACE ROOF

rangement of baffles, but results in a similar case of baffling will serve to indicate that a high efficiency is attainable.

Data is, however, available, showing the effect due to the use of a balanced draft. The average of four simultaneous tests with a chain grate stoker located under a Babcock & Wilcox boiler gave the following average results:

| | Boiler A. Natural Draft. | Boiler B. Forced Draft. |
|---|---|---|
| Thickness of fire in inches | 7.0 | 7.0 |
| Per cent. of coal used that would pass through 1/8 inch round screen..... | 13.1 | 13.1 |
| Total strength of draft in inches of water..... | 0.389 | 0.380 |
| Draft over fire in inches of water ..... | 0.389 | 0.00 |
| Per cent. $CO_2$ in furnace gases ..... | 5.03 | 7.32 |

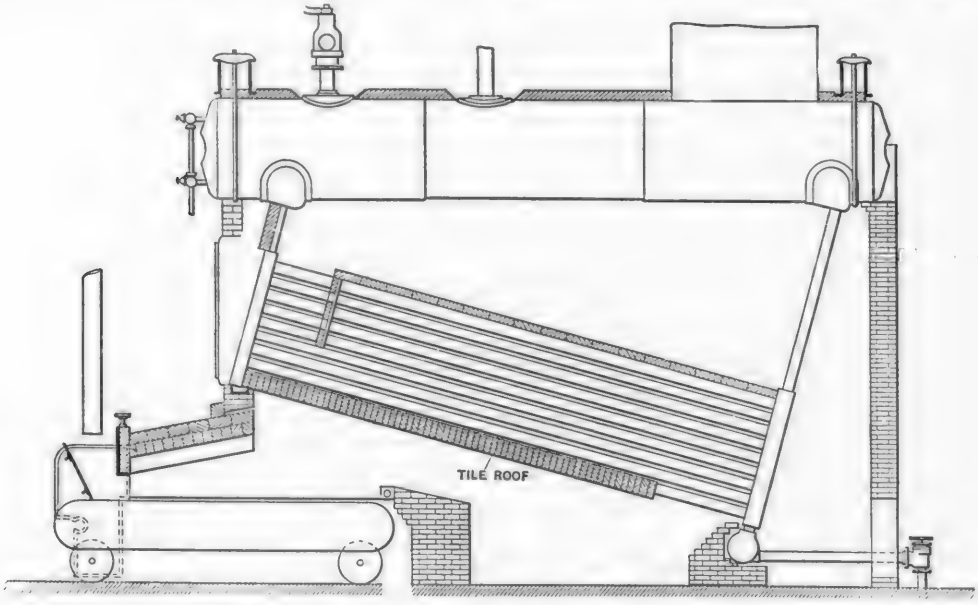


FIG. 4. BOILER WITH TILE ROOF FURNACE

Each of these tests covered a period of four hours and measurements were made at 15-minute intervals. Coal from exactly the same lot of fuel was used in each series of tests, so that a test for each kind of draft was made with a uniform lot of coal, thus avoiding the possibility of the fuel having an influence on the results. With each of these stokers there was a considerable opening at the end of the grate at the bridgewall, which, however, was the same in each series of tests. Otherwise a higher per cent. of carbon dioxide would probably have been realized. The tests on each boiler were conducted at the same time, and alternating wheelbarrows of coal were supplied to the boilers.

So far as the author is aware, there are no features of the above apparatus which are patented.

## Weights and Measures

By Henry R. Towne

Upon this subject, Mr. Towne read a paper before the recent meeting of the American Society of Mechanical Engineers.

Although addressed to engineers, the paper is an appeal that all classes and interests shall unite in urging that the question of improving our system of weights and measures shall be referred to a technical commission, to be appointed by the President, whose report shall form a basis for permanent legislation.

Since 1816 this subject has been before Congress, but without action, save the law of 1866, which legalizes the use of the metric system. No other great nation has acted on this question except on the basis of previous investigation by a technical commission. The need for this is greater in our case than any other, because of the highly developed state of our industries, most of which would be profoundly disturbed by any radical change.

France, Germany, and each of the smaller states which have adopted the metric system did so to obtain unity of weights and measures in place of a chaos of old units. We have absolute unity now, but would lose it by attempting to change to a new system, a change which as proved by the experience of France would not be completed in one hundred years. We now have also absolute unity with the British Empire save as to measures of volume.

Decimal notation is possible with any system, but although desirable for computation and scientific work, is unacceptable for the daily uses of the people, the latter invariably resorting to binary division. Our present "tables" can be simplified and improved without changing our units, the grain, the inch, and the gallon, which are as good as if not preferable to the metric units. Measures of length in many respects are immutable, are "linked irrevocably to the past."

The annual value of the manufactures of the United States and of Great Britain and her colonies (having a combined population of 150 millions) is $11,000,000,000, and is equal to that of the combined manufactures of the eight largest manufacturing countries using the metric system. The adoption by us of their units of measurement would not affect their purchases from us, any more than their present use of the metric system affects our purchases from them. Of our total foreign trade in 1905, 49 per cent. was with Great Britain and the British Empire, or, if Russia and China are included, 54 per cent. The essential question is, what system is best for us, and this should be studied by a competent and fairly large Technical Commission, representative of all the great interests concerned.

John Quincy Adams is quoted as saying in his memorable report on this subject, "If there be one conclusion more clear than another, deducible from all the history of mankind, it is the danger of hasty and inconsiderate legislation upon weights and measures," a statement even truer to-day than in 1821. Therefore, before deciding what action, if any, is expedient, we should do as every other great nation has done, refer the whole question to a competent Technical commission for exhaustive investigation and report. A bill to accomplish this has been introduced in Congress and forms an appendix to the paper.

## Mechanical Engineering Index

By Prof. W. W. Bird and Prof. A. L. Smith

The index described in this paper, which was read at the recent meeting of the American Society of Mechanical Engineers, consists of a series of tab cards, one for every subject connected with the subject of mechanical engineering. The cards are arranged in alphabetical order, so that any given topic is easily found. Back of each tab card is a series of colored cards, each of which has to do with a given subject. Blue cards give a list of the latest books; salmon cards, a list of trade catalogues; white cards, references to recent papers which have been read before engineering societies and form a part of their transactions; green cards give a list of theses; and amber cards one for each good article on the given subjects which has appeared in some engineering paper.

The index is maintained by the instructors in the department of mechanical engineering at the Worcester Polytechnic Institute, to each of whom books and papers are regularly assigned, reports being made at department meetings on specially prepared cards which are then filed in the index.

Copies of the forms used and a full list

of the subjects indexed are printed in the paper. The index has been in constant use for a number of years and has proved very satisfactory in the maximum amount of information to be found on a given subject in one place and in the minimum amount of work required for its maintenance.

### A Plan to Provide Skilled Workmen

By W. M. Alexander

Mr. Alexander presented a paper on this subject before the recent meeting of the American Society of Mechanical Engineers which aroused much favorable comment.

It is generally conceded that the development of American mechanical industries is endangered by an insufficient supply of skilled workmen. The reason for this may be found in the enormous expansion of these industries in recent years which has made the demand for skilled workmen greater than the supply; and in the great specializing tendency in all industrial activities, in consequence of which manufacturers have not paid sufficient attention to the training of all-round skilled artisans.

The plan outlined in this paper deals with the manufacturer's side of the problem and describes a modern apprenticeship system, successfully developed by the General Electric Company at West Lynn, Mass. This system was evolved after a study of the prevailing systems, and it aims to overcome what the author considers their weaknesses.

By the plan adopted by the General Electric Company at West Lynn, apprentices are kept in the training room for about two years under expert instruction on commercial work, especially selected from the whole work in the factory. They are then sent into the factory department for the remaining two years of the course in order to acquire greater speed and skill on a larger variety of work.

The General Electric Company has established so far two training rooms; one for machinist and tool maker apprentices with about 10,000 square feet of floor space and about 105 representative machine tools, and a smaller one of wood and metal pattern maker apprentices with a floor space of about 1,000 square feet. A training room for foundry apprentices has not yet been found necessary on account of the small number of such apprentices so far indentured.

A special school is conducted, in connection with the apprenticeship work, in which the elementary and some of the more advanced sciences are taught in a practical way in their application to everyday factory life. Engineers, draftsmen and foremen of the Company who possess the necessary qualifications act as instructors in this school which is in session during a part of the regular working time.

This paper endeavors to prove the feasibility of establishing similar training rooms and lecture courses for much smaller concerns than the General Electric Company; a common training room for several small factories in a locality; and finally, an independent and self-sustaining training room—a new and practical trade school for the benefit of the industries of a community. The papers then considers the other element in providing for a constant supply of skilled workmen, i. e., the possibilities of making skilled specialists, and eventually of developing unskilled workmen into skilled artisans. It suggests that the factory be utilized for this purpose during evening hours. The training room is shown to be especially suited for this industrial educational extension work.

The successful working out of these ideas by manufacturers quite universally would go a long way toward overcoming the lack of skilled labor. At the same time the State could gain from these practical efforts valuable information as to the establishment of proper trade schools necessary for the complete solution of this industrial problem.

### Local Chapter for Illinois Members

Secretary W. M. Mackay announces that the amendment to the by-laws of the Society providing for local chapters has been adopted. This proposed amendment was submitted to the members by mail ballot. Its passage was made the occasion of a meeting of the Illinois members at the Sherman House, Chicago, December 3d. where the organization of an Illinois chapter was affected. If the applications for membership from Illinois are favorably passed upon, by the Society, the Illinois Chapter will start its career with 42 members. It is intended to hold meetings the second Monday of every month, except during the summer.

The following were elected officers of the Illinois Chapter: President, T. J. Waters; Secretary, John T. Hale; Treasurer, August Kehm; Board of Governors, George Mehring, S. R. Lewis and E. F. Capron; Committee on Legislation to draft ventilation bill for Illinois legislature, James Mackay, George Mehring and E. F. Capron.

A special meeting of the New York members of the Society was held at the Arena restaurant, New York, December 11th, with a view to discussing the preparations being made for the coming meeting of the Society in January.

THE HEATING AND VENTILATING MAGAZINE

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WITH the appearance in this issue of the weather records of five cities for the month of November, our plan as previously outlined in these columns for the publication of such records, is now permanently established. The cities chosen cover a wide range of territory and give, as accurately as is practicable, the weather conditions in the sections in which they are located. It will be noticed that two of the cities face the Atlantic, while one borders on one of the Great Lakes and the remaining two are located in the interior of the country. We should be pleased to be advised by any of our readers in case the general weather conditions found in any other city are sufficiently unlike those published as to warrant their being included in the present list, since it is our purpose eventually to make the charts a general guide to the heating engineer in his work in all the important sections of the country.

It is gratifying to know that the weather charts, including those published in our last issue, for the years 1887–1898, have proved of such interest and value to our readers as is evidenced by a letter from a prominent New York heating engineer, who says concerning them:

"I believe that in the presentation of weather charts, in such a comprehensive form, you have given information of the greatest service to every heating engineer. Those for the entire year are extremely interesting, but not more so than the ones you have presented for the month of October. I trust that you will follow up these monthly diagrams, as they will be of extreme value, not only at the moment, but for future reference."

AS WE observed last month, it is to be noted in studying the charts that they are plotted from figures especially prepared for us by the local United States weather bureaus in the various cities and that they are a record of the conditions observed at those stations only. In every case, we believe, the stations are located at the tops of high buildings where we have found the thermometer usually reads a few degrees lower than at or near the street level. In cold weather, however, this is probably quite compensated for by the increased wind currents on one or more sides of a building, near the street, due to the obstructions encountered by the wind at this level.

AN ECHO of the discussion heard at the recent summer meeting at Chicago of the Heating Engineers, regarding the variations in the heat losses from buildings where the difference in the inside and outside temperatures varies, will be found in this issue in a letter from Mr. Walter Jones, of Stourbridge, England, whose paper on "Heat Losses and Heat

Transmission'' led to the discussion referred to. The immediate cause of Mr. Jones's remarks is the heat loss chart, compiled by Mr. R. P. Bolton, and published in our August, 1906, issue, in which the heat unit losses, as given in the chart, do not allow for any differences in the rate of heat loss. In addition to Mr. Bolton's remarks regarding this point of Mr. Jones's, it is interesting to recall the remarks of some of those who discussed the subject at Chicago. Prof. Kinealy, for instance, said among other things "none of these men (Prof. Rietschel, C. F. Hauss, J. H. Mills and others) would, for an instant, say that the loss for a difference of temperature of one degree was only one-seventieth of the loss for a difference of a temperature of 70 degrees, but in order to make the calculations of the engineer simple, that is what they state. . . . In ordinary work we cannot go into the small differences which undoubtedly exist." Other speakers gave it as their experience that the raising of the temperature in a room, for instance, from 70 to 80 degrees required an additional amount of radiation considerably greater than that obtained by following the calculations of most heating authorities.

As Mr. Bolton observes, however, this theory has yet to be reduced to some accepted basis, besides being adapted to the most modern materials, such as reinforced concrete, which has come into such wide use in the construction of buildings.

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THE paper on "Ventilation of the Boston Subway," by Mr. H. A. Carson, which was read early this month before the American Society of Mechanical Engineers, contains, in addition to a description of the subway ventilation, some interesting memoranda regarding the condition of the air in various halls, theaters, churches and schools in Boston, in all of which a higher proportion of carbon dioxide was noted than in the subway itself when the ventilating plant was not in operation. From this the writer argues that if the proportion of carbon dioxide were the only consideration, the condition of the air at other places would appear to justify the omission of positive ventilation in subways. It is a remarkable fact, in passing, that in a well-filled hall in Boston and in four of the principal theaters in Boston, the amount of carbon dioxide in the former was found to vary from no less than 32.59 to 36.43 parts in 10,000 vols. of air, and in the latter from 6.16 to 48.7 parts in 10,000.

The speaker concludes, however, that "the fitness of air in a subway for breathing can probably be better ascertained by means of sensitive noses of persons used to fresh air than by the ordinary methods of chemists. Crowded, unventilated subways contain not only carbonic acid and other matters thrown off from human lungs, but have also, widely diffused through the air, fine dust from the ballast, fine particles of oil from the machinery, and finely ground particles of iron from the brake shoes."

One of the notable observations made by Mr. Carson was of the bad state of the air found in the cars themselves while at the street level. In one car, equipped with ventilators and containing about 65 passengers, a sample taken at 8:30 A. M., on a cold winter's day, the proportion of carbon dioxide ran as high as 24.97, which would seem to prove, as the writer states, that a system of subway ventilation is incomplete unless the cars also are ventilated.

# CORRESPONDENCE

## Figuring Flow of Air in Metal Pipes by Chart

I enclose $1.00 for subscription to THE HEATING AND VENTILATING MAGAZINE. I enjoy the reading of it very much and appreciate the constant improvement in the amount and character of the reading matter. I have used the chart given by Mr. B. S. Harrison in the December, 1905, number, and in comparing some computations of my own of sizes of air ducts I find that the velocities indicated by his method are very high, or that the pressures corresponding to my own method are very low. I have searched for some reliable formula giving the velocity of air due to pressure, but fail to find any. Would be obliged if you could refer me to such a one.

Yours respectfully,

A. R.

New York, November, 1906.

ANSWER BY B. S. HARRISON

In reply to A. R. regarding the velocities of air delivered through ducts of different sizes and lengths as shown on my chart in the Dec., 1905, number of the magazine, I herewith enclose a diagram which shows the method used in plotting the chart.

Curve "A" on the diagram represents velocities of air in feet per minute due to different pressures per square inch in ounces.

The horizontal spaces at the base of the diagram each represent 1-32 oz. pressure; the vertical spaces at the left of the diagram each represent 250 feet velocity in the flow of air.

Curve "B" represents the amount of pressure in ounces per square inch of pipe area lost in friction in a pipe 12 inches in diameter and 100 feet long, when delivering air at its far end at different velocities. This friction loss to be taken care of by additional initial pressure.

Curve "A" is plotted to the same scale as curve "B."

Suppose that instead of both curves being plotted on the same paper, one (curve "B") is plotted on tracing cloth, and a similar curve plotted on the same cloth for each size of pipe which it is desired to figure. Separate tracings may be used for the different length of run.

To use the curves, proceed as follows:

Suppose the desire is to find the velocity of the air delivered from the end of a 12-inch pipe one hundred feet long when the initial pressure is $\frac{3}{4}$ oz. per sq. in.

Superimpose curve "B" over curve "A" so that the base lines coincide and the curve "B" starts on the $\frac{3}{4}$ oz. division at the base of curve "A." The two curves cross at a point opposite 2,400 feet velocity per minute on the scale at the left of the chart. (See the diagram.)

From the point of intersection of the two curves, the horizontal spaces to the right to the end of curve "B" represent loss of pressure due to friction while the spaces to the left to the edge of the chart represent net pressure causing velocity delivery at the end of the pipe.

The area of a 12-inch round pipe is .785 sq. ft. At 2,400 feet velocity the delivery would be 1,884 cu. ft. per minute, as shown on my curve sheet of last December.

The curves of friction "B" are plotted from the Sturtevant formula $P=\frac{L\ V^2}{2{,}500\ D}$, in which P=loss in pressure in oz. per sq. in.; L=length of run in feet; V=velocity in feet per minute and D=diameter of pipe in inches.

Velocities due to pressure may be figured or obtained from hand books.

B. S. HARRISON

## A Cure for Smoky Chimneys

Editor HEATING AND VENTILATING MAGAZINE:

The writer has a chimney in his house that persists in filling the room with smoke every time a hard wood fire is started. Would you recommend a chimney top? and if so what make do you consider the best. Or kindly name a few makers of tops if several are "the best."

Oswego, N. Y. KARL KELLOGG.

This trouble is one frequently met with and is usually due to the column of cold air in the chimney when there is no fire. An easy way of overcoming this trouble is to start the fire with a few handfuls of shavings or other inflammable material that will send a sudden flash of heat up the flue. As soon as a current of hot air is obtained through the flue, there should be no further trouble. It sometimes happens that the construction of the chimney is faulty in that it does not extend above the ridge of the roof. That would cause trouble when the wind was from a certain direction. It would also be well to have a look down the chimney itself, as in one case that has come to our notice, such an inspection disclosed a board weighted with a heavy stone lying over the opening and effectually closing it.

## Mr. Bolton's Heat Loss Chart

Editor HEATING AND VENTILATING MAGAZINE:

We beg to acknowledge the receipt of the chart giving "Scale of Heat Losses," which appears to us to have the faults common to all other published tables, or charts of heat losses.

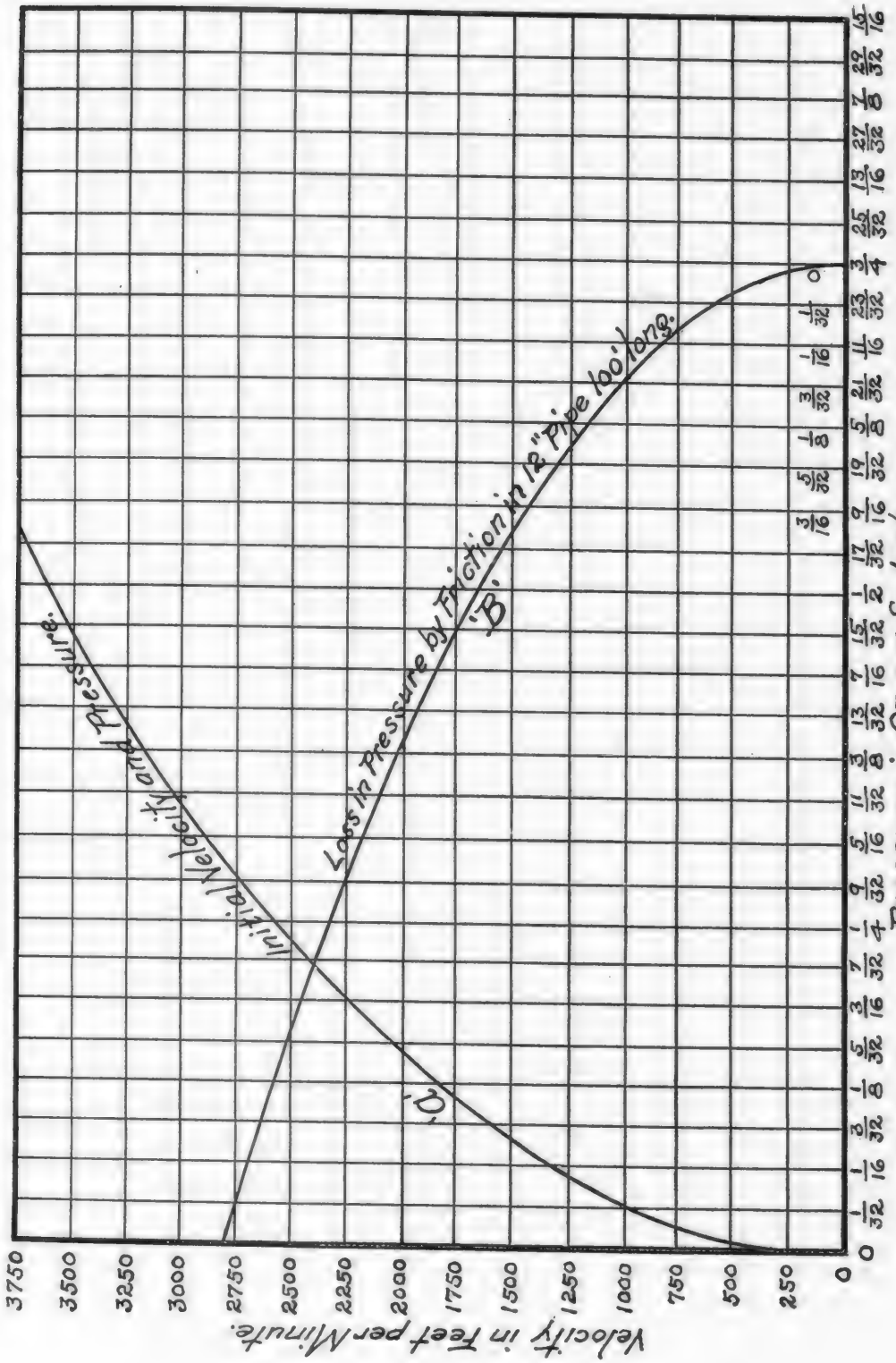



DIAGRAM SHOWING METHOD USED BY B. S. HARRISON IN PLOTTING AIR VELOCITY CHART

We assume the diagram to be a correct record of the temperatures or meteorological conditions in New York for 1903–4. If the heat losses shown thereon were real losses, ascertained from actual tests, they would be extremely valuable, but as they appear to be calculated losses taken from Table 4, page 22, of Mr. J. R. Allen's "Notes on Heating," or from a similar source,* the results are unreliable, and therefore, of little value. You say "it is only necessary to multiply the exposed areas of different constructions by the number of heat units thus scaled off."

We presume the area referred to is per square foot, per hour. The chart does not make this clear; it may be per square yard, or per day. The losses per degree difference are marked the same for all temperatures, whether the difference in temperature be 7 or 70 degrees, but in practice this is not so, as the difference between inside and outside temperatures increases, the ratio (or loss per degree difference) also increases; it is not a constant. Hence the chart is of little value for calculating the actual losses, or the radiating surface required to provide for such losses.

The chart is an excellent example of graphical work, carefully executed, well printed on good paper, and as a record of average temperatures in New York is interesting, but for the main purpose of a Heating Engineer, it does not supply the information most needed.

JONES & ATTWOOD.
W. JONES.

Stourbridge, England.

*Peclet's losses of heat units are the ones shown in the chart.—Ed.

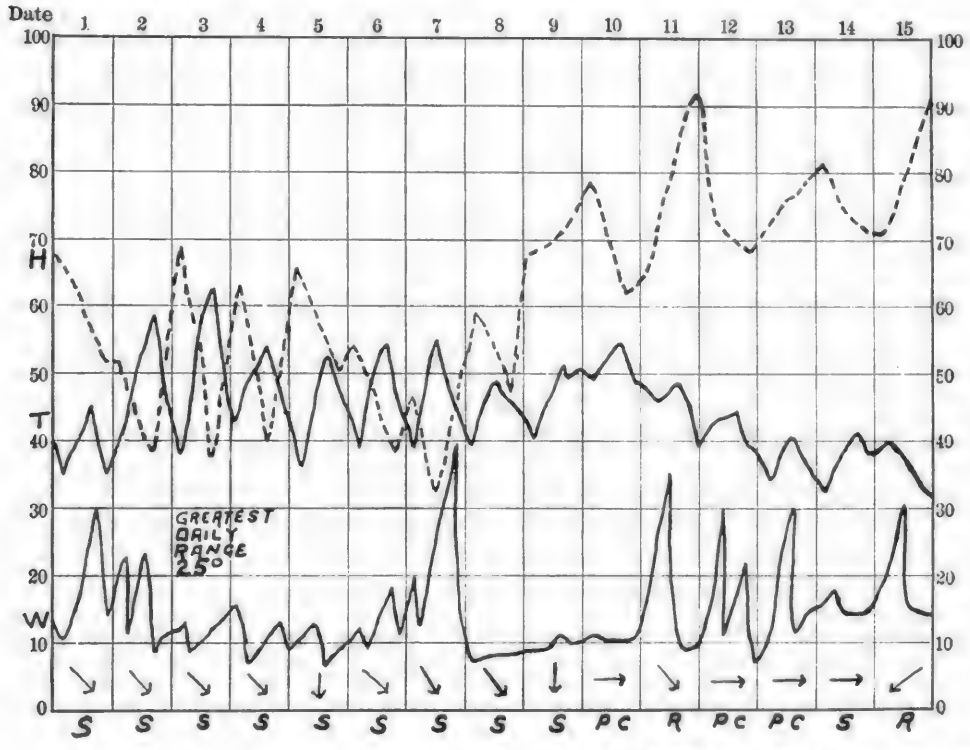
ANSWER BY R. P. BOLTON

I have read with interest the letter received from Mr. Walter Jones, of Stourbridge, in which he takes the view that my diagram, of heat losses related to our average temperature variations, is unreliable, on account of the scales of heat units being based on the assumption that the ratio is similar for all degrees of interior and exterior difference.

Referring to Mr. Jones' paper, read this year at Chicago, before the American Society of Heating and Ventilating Engineers, I note that Mr. Jones says:

"All the tables prepared by Professors Carpenter, Rietschel, Hauss, Mills and others, that have come under my notice, assume that the T. R. (multiplier to cover difference in temperature) losses are practically the same at all temperatures; the losses for a difference in temperature of 70 degrees are given as 70 times the loss for 1 degree."

Mr. Jones proceeds in his paper to state his theory as to finding a basis of calculation for variation in temperature ratio, but after presenting a table of his compu-




RECORD OF THE WEATHER IN

**Upper black line indicates temperature in degrees Fahr.**
**Dotted line indicates relative humidity in percentage**

tations, his final remarks leave the subject in a confused condition, he evidently having little faith in the definiteness of the conclusions presented.

My chart was naturally scaled in accord with accepted practice in this matter. I agree that theoretically Mr. Jones may be right, but his theory has yet to be reduced to some accepted basis, and further, the variations of the scales have to be shown to be of different importance in such materials as enter into the composition of the exterior parts of buildings, to make the complication introduced by their adoption worth the while.

So I will maintain, Mr. Jones to the contrary notwithstanding, that the diagram is practical and reliable, and in accord with the practice and statements of the standard authorities.

When Mr. Jones establishes to the satisfaction of the profession, what are the ratios of variation between the accepted interior temperatures of 70 degrees in this country, or 60 degrees in England, and outside corresponding temperatures, I will be pleased to embody them in revised diagrams, but will point out that the wind movement would be a far more important element, and is more probably the cause of all the difficulties to which his paper was directed, than the subject to which he attaches such prime importance.

REGINALD PELHAM BOLTON.

## The Weather During November

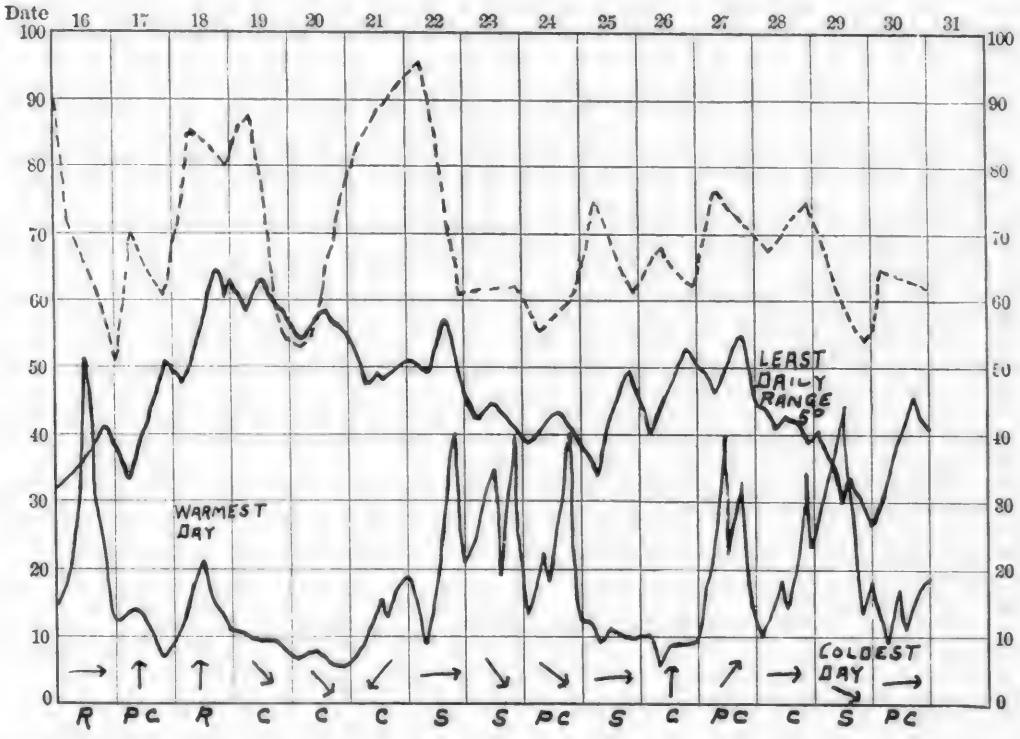
Some features of the weather during November in the cities of New York, Boston, Chicago, Pittsburg and St. Louis are noted in the following summary:

NEW YORK

In New York, the highest temperature was 64° on the 18th, and the lowest, 27° on the 29th. The greatest daily range was 25° on the 3rd and the least daily range, 5° on the 28th. The mean temperature for the month was 44°, corresponding to the normal temperature for 36 years. There were 1.28 inches of rain, 0.57 inches falling on the 15th and 16th. The prevailing direction of the wind was northwest and the total movement, 9,919 miles; average hourly velocity, 13.8 miles; maximum velocity for 5 minutes, 51 miles from the west on the 16th. There were 14 clear days, 8 days partly cloudy, 8 cloudy and 4 rainy

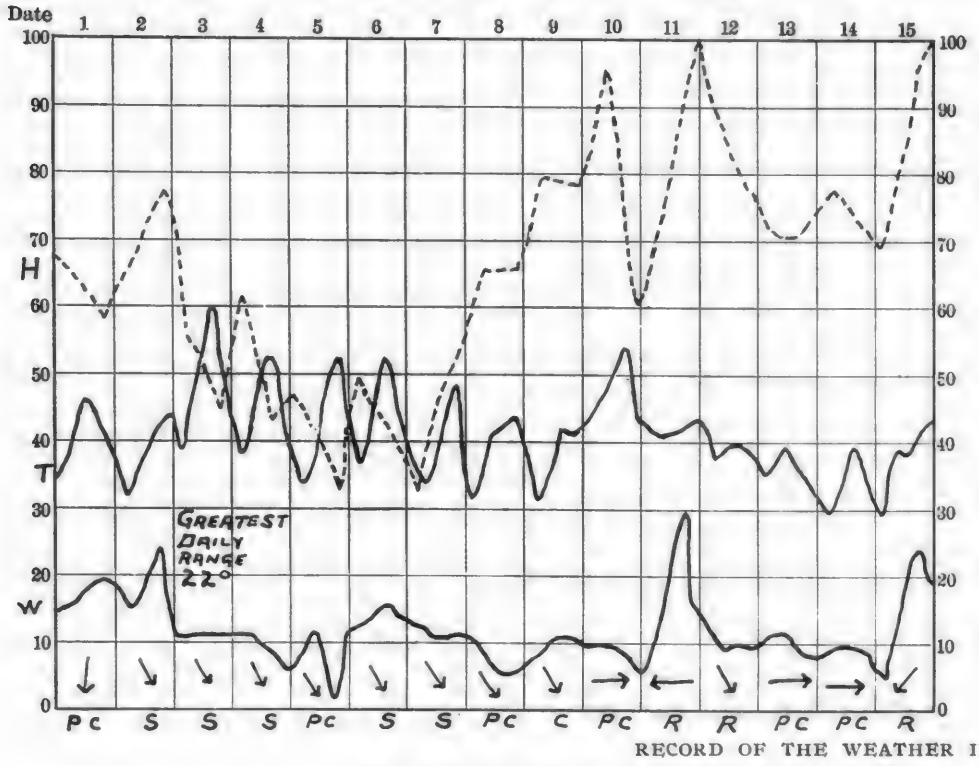
BOSTON

In Boston, the highest temperature recorded was 68 on the 18th, and the lowest, 23 on the 30th. The greatest daily range was 22 on the 3rd and the least daily range, 3 on the 28th. The mean temperature for the month was 41 which corresponds to the normal temperature for 36 years. The total rainfall for the month was 2.55 inches. The greatest rainfall in any one


Date
16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
100 90 80 70 60 50 40 30 20 10 0
LEAST DAILY RANGE 5°
WARMEST DAY
COLDEST DAY
R PC R C C C S S PC S C PC C S PC

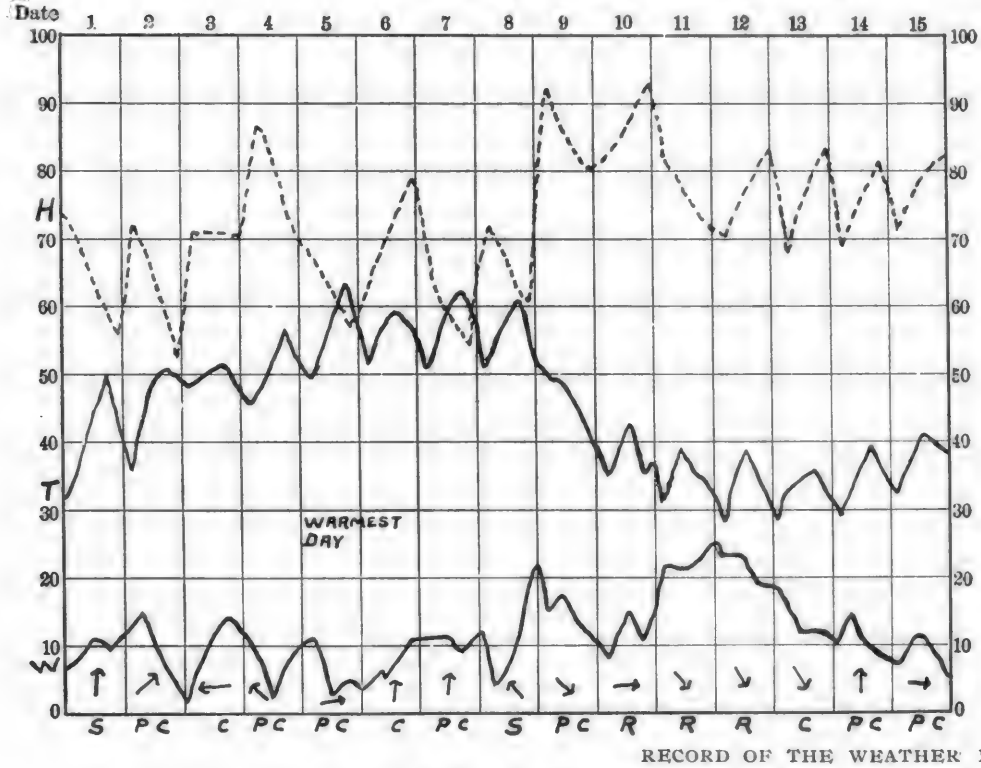
NEW YORK CITY FOR NOVEMBER, 1906

Lower line indicates velocity of wind in miles per hour
Arrows fly with prevailing direction of wind
S—Clear. PC—Partly Cloudy. C—Cloudy. R—Rain



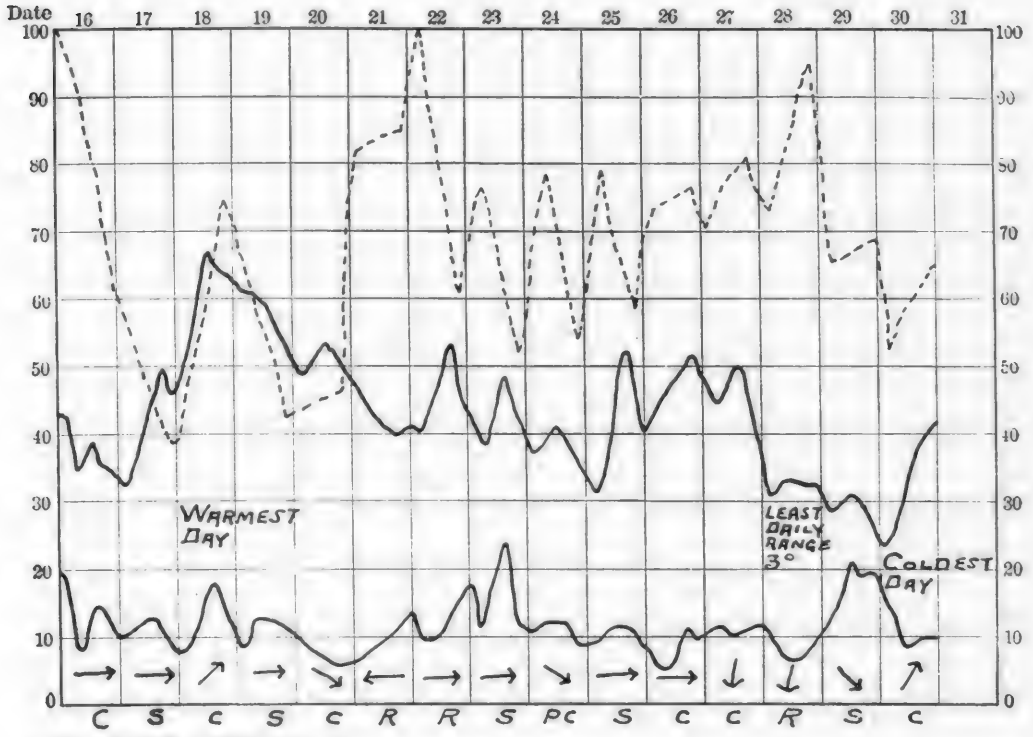

RECORD OF THE WEATHER IN

Upper black line indicates temperature in degrees Fahr.
Dotted line indicates relative humidity in percentage



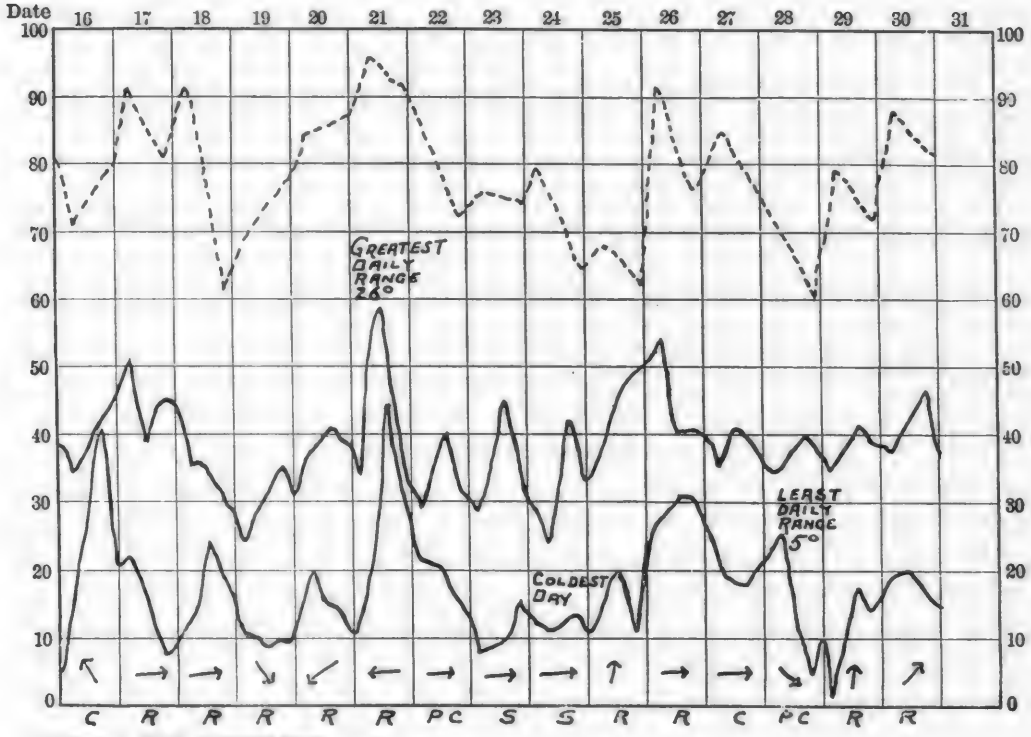

RECORD OF THE WEATHER IN

Upper black line indicates temperature in degrees Fahr.
Dotted line indicates relative humidity in percentage



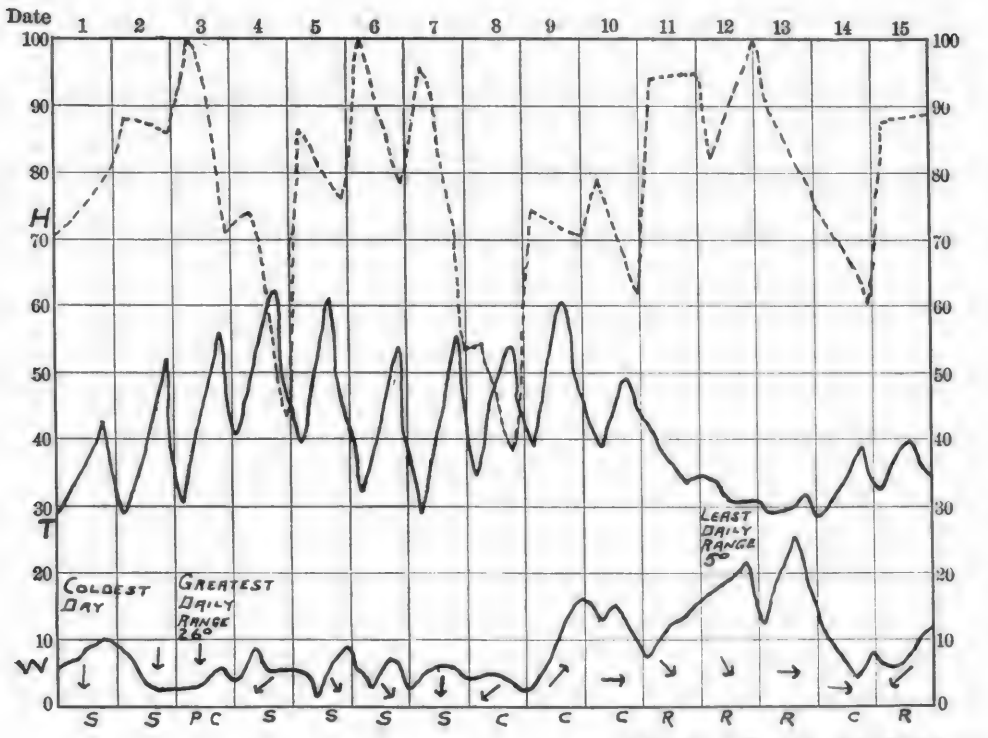

BOSTON FOR NOVEMBER, 1906

Lower line indicates velocity of wind in miles per hour
Arrows fly with prevailing directions of wind


Date
16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
100 90 80 70 60 50 40 30 20 10 0
GREATEST DAILY RANGE 26°
LEAST DAILY RANGE 5°
COLDEST DAY
C R R R R R Pc S S R R C Pc R R

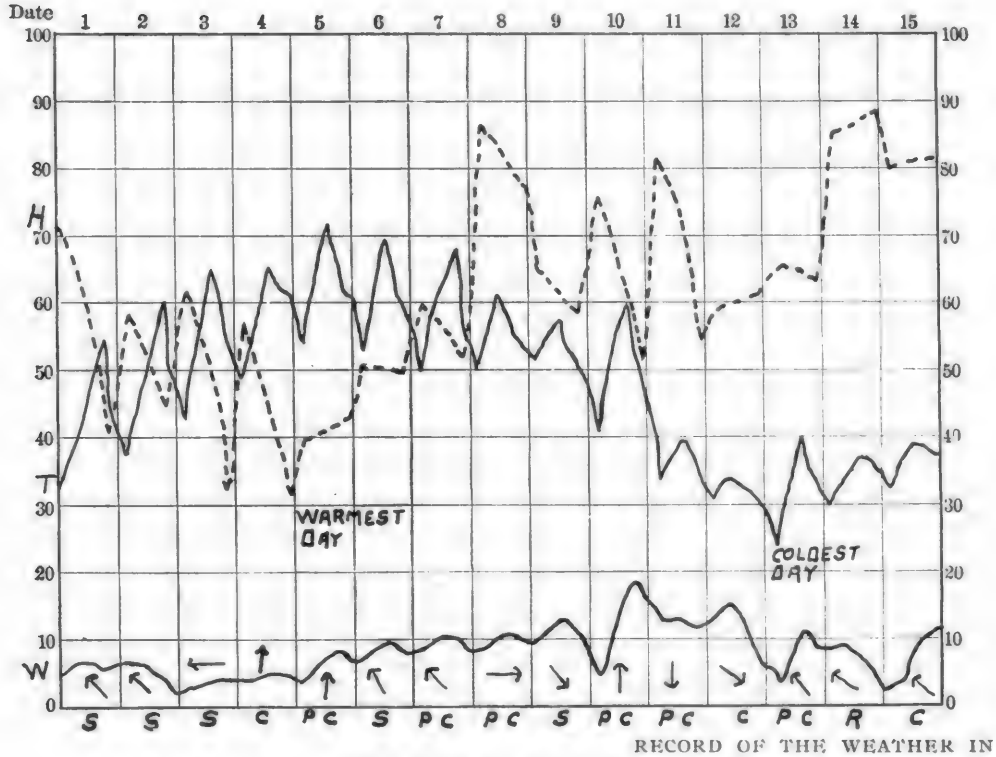
CHICAGO FOR NOVEMBER, 1906

Lower line indicates velocity of wind in miles per hour
Arrows fly with prevailing direction of wind
ly Cloudy. C—Cloudy. R—Rain



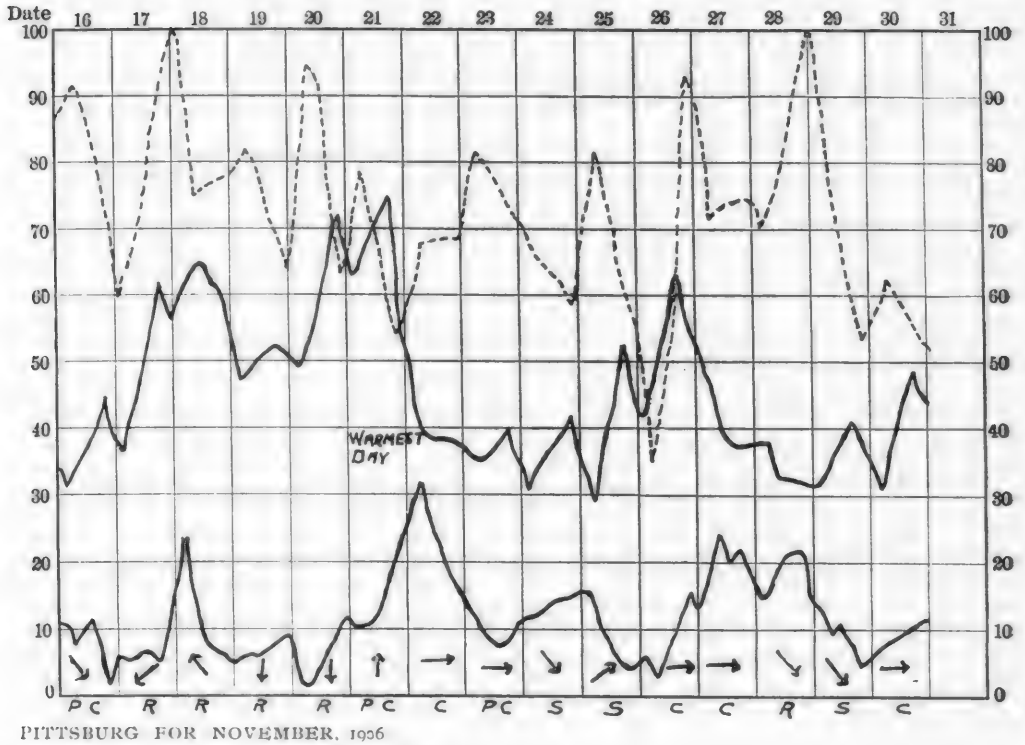

RECORD OF THE WEATHER IN

Upper black line indicates temperature in degrees Fahr.
Dotted line indicates relative humidity in percentage



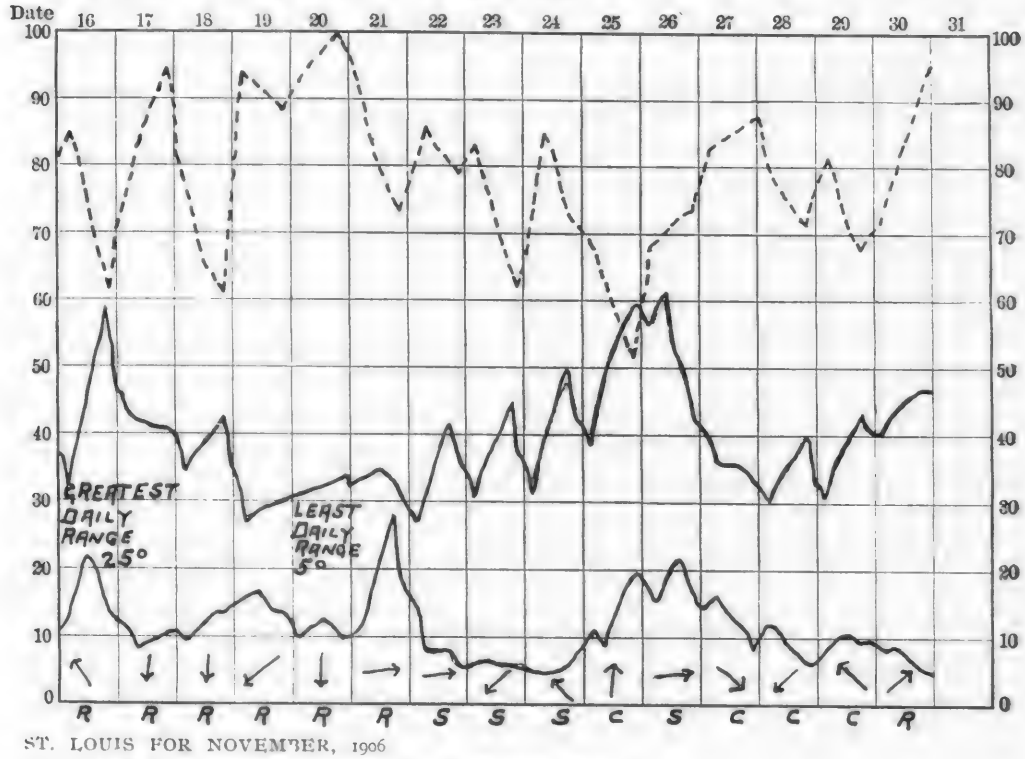

RECORD OF THE WEATHER IN

Upper black line indicates temperature in degrees Fahr.
Dotted line indicates relative humidity in percentage




PITTSBURG FOR NOVEMBER, 1906

Lower line indicates velocity of wind in miles per hour
Arrows fly with prevailing direction of wind
S—Clear. PC—Partly Cloudy. C—Cloudy. R—Rain




ST. LOUIS FOR NOVEMBER, 1906

Lower line indicates velocity of wind in miles per hour.
Arrows fly with prevailing direction of wind.
S—Clear. PC—Partly Cloudy. C—Cloudy. R—Rain

day was 1.15 inches on the 15–16th. There were 1.0 inches of snow. The prevailing direction of the wind was northwest and the total movement, 8,210 miles; average hourly velocity, 11.4 miles; maximum velocity for 5 minutes, 39 miles from the northeast on the 11th. There were 10 clear days, 12 rainy days, 9 days partly cloudy and 11 cloudy.

CHICAGO

The highest temperature recorded for the month was 64 on the 5th, and the lowest, 25 on the 24th. The greatest daily range was 26 on the 21st, and the least daily range, 5 on the 28th. The mean temperature for the month was 39, corresponding to the normal temperature for 36 years. During the month 3.08 inches of rain fell, the greatest amount of rain in any one day being 1.52 inches on the 20th and 21st. There were 2.8 inches of snow. The prevailing direction of the wind was west; total movement, 10,471 miles; average hourly velocity, 15 miles; maximum velocity for 5 minutes, 59 miles from the southwest on the 21st. There were 4 clear days, 11 partly cloudy, 15 cloudy and 13 rainy.

PITTSBURG

In Pittsburg, the highest temperature for the month was 75 on the 21st, and the lowest, 27 on the 1st. The greatest daily range was 26 on the 3rd and the least daily range, 5 on the 12th. The mean temperature for the month was 42, corresponding to the mean temperature of this month for 36 years. There was 0.95 inch of rain, 0.33 inch falling on the 17th and 18th. There was 0.5 inch of snow. The prevailing direction of the wind was west and the total movement, 6,737 miles; average hourly velocity, 9.4 miles; maximum velocity for 5 minutes, 43 miles from the west on the 22nd. There were 9 clear days, 4 days partly cloudy, 17 cloudy and 11 rainy.

ST. LOUIS

The highest temperature for the month was 72 on the 5th, and the lowest, 26 on the 13th. The greatest daily range was 25 on the 16th, and the least daily range, 5 on the 20th. The mean temperature for the month, 45, 1 below the average for 34 years. The total rainfall was 4.67 inches, 1.44 inches falling on the 16th and 17th. There were 2.0 inches of snow. The prevailing direction of the wind was southeast; total movement, 6,734 miles; average hourly velocity, 9.4 miles; maximum velocity for 5 minutes, 36 miles per hour from the west on the 21st. There were 9 clear days, 6 partly cloudy, 15 cloudy and 8 rainy days.

## Citizens' Industrial Association

Mr. C. W. Post, of Battle Creek, Mich., was elected president for 1906-1907 of the Citizens' Industrial Association, which held its annual meeting recently in Chicago.

## Direct Leakage of Steam Through Slide Valves*

By J. V. Stanford,

Assistant Professor in the Mechanical Engineering Department, University of Pennsylvania.

When the weight of steam used in an engine, as determined by condensing the exhaust, is compared with that computed from the indicator card, it is well known that there is considerable difference in the results. This difference between the actual and computed weights, commonly called "the missing quantity," and in some cases amounting to as much as 50 per cent. of the steam used, is generally considered as being accounted for by condensation in the cylinder. The indicator card shows only the actual weight of vapor in the cylinder at a given time, taking no account of the steam which has entered the cylinder and has been condensed by transfer of heat to the cylinder walls. There is no doubt that a large part of the missing quantity may be charged up to cylinder condensation, but there is a possibility that some of it may be due to another cause, namely, valve leakage.

Leakage through the valves of a steam engine may affect the results of an investigation of the engine in various ways. If the steam valves of a Corliss engine leak steam to the cylinder after cut-off, the indicator card should show the expansion line carried above its normal position, and a determination of the steam used, based on the pressure and volume near the end of the stroke, would probably include this leakage. If the exhaust valves leak, however, the expansion line will fall off, and a calculation from the card as before would fail to show the leakage, which would then become a part of the missing quantity. In the case of a slide valve, practically the same thing is true; any leakage from the steam chest to the cylinder will be taken care of by the indicator card, but leakage to the exhaust, either from the cylinder or chest over the bridge, or from the steam chest past the sides of the valve, is not shown by the indicator card, but forms part of the weight shown by the condenser.

TEST OF STURTEVANT BLOWER ENGINE

The object of this paper is to give the results of some experiments that have been made at the Mechanical Laboratory of the University of Pennsylvania, to determine some facts in connection with leakage of slide valves.

A set of tests was made on a 6x9 inch Sturtevant blower engine, driving a three-quarter housed centrifugal fan keyed direct to the shaft. The engine and fan had been installed in the boiler house of the University to create forced draft, and after a short period of use had stood idle with only an occasional run when used by the students for practice in valve

*From a paper read November, 1906, before the Franklin Institute, Philadelphia.

setting. The engine has no governor, depending upon the throttle and the steady resistance of the fan to maintain the proper speed, and the valve is driven direct by the eccentric through a rocker arm.

The valve is of the common D slide valve type, 5 inches wide by 4¾ inches long, overlapping the ends of the ports ¼ inch on either side. The engine had evidently been designed to work with the cut-off fixed at about .65 of the stroke, and during the tests the valve was set to give this cut-off. With this setting the minimum width of bridge covered by the valve was ⅜ inch, so that the exhaust port was everywhere protected from direct leakage by contact between the valve and seat at least ¼ inch in width.

A balance plate extends between the valve and chest cover to relieve the pressure between the valve and seat, and reduce the resulting friction. The balancing device consists of a cylindrical cup, bearing against a circular boss on the chest cover, and telescoping over a cylindrical projection from the top of the valve, the telescoping joint being made tight by two split rings. Contact is maintained between the balance plate and chest cover by four light springs. Steam leaking through the packing rings to the inside cavity of the balance plate is discharged through two $\frac{3}{16}$-inch holes in the top of the valve direct to the exhaust cavity, so that the pressure over a large part of the valve is exhaust pressure. This leakage is also part of the missing quantity, for it goes to the condenser without affecting the indicator card.

In preparing for the tests, the engine exhaust was piped to a surface condenser, and arrangements made for collecting and weighing the condensation; a pressure gauge was attached to the steam chest and a revolution counter geared to the eccentric strap. Indicator cards were also taken.

### RESULTS OF TESTS

Two runs were then made with the engine working normally under the load of the fan, with the balance plate on the valve, and readings were taken to give weight of steam condensed, revolutions per minute, pressure in the steam chest, and the indicated horse power. Average results from the two tests showed that the engine was developing about 5.13 horse-power, and was using about 91.2 pounds of steam per indicated horse-power per hour.

The balance plate was then removed from the valve, the holes through the top of the valve plugged with wood, leaving the valve unbalanced, and tests run as before. These tests gave a steam consumption of 60.5 pounds per indicated horse-power per hour, or 30.7 pounds less than when the balance plate was in place, due to the difference in leakage.

In the first case the leakage was through the balance plate and under the valve; in the second case under the valve only, but the difference was probably due, not so much to leakage through the balance plate, as to the fact that in the first case the valve was only lightly seated, while with the balance plate removed it was seated firmly by the whole pressure of the steam and a good joint maintained with the seat.

In order to determine the actual amount of leakage, the steam ports of the engine were plugged by driving in blocks of dry white pine, filling the steam passages flush with the valve seat. One cylinder head was then removed and the stuffing box opened to relieve any pressure in the cylinder due to leakage through the plugs. The eccentric sheave was loosened on the shaft and bolted to a large wood pulley placed beside it. The pulley was belted to a one horse-power electric motor, geared to drive the pulley and eccentric about the shaft at the same speed as had been used in the previous tests. Having thus reproduced the conditions of running of the valve as nearly as possible, except that all passage of steam to and from the cylinder was eliminated, it was fair to assume that all the steam now reaching the condenser was due to leakage from the chest to the exhaust and that the amount was practically the same as when the engine was running normally. In running these tests, the motor was started and adjusted to the proper speed, then the throttle valve was opened carefully until the pressure in the chest was the same as in the other tests. Considerable difficulty was experienced in making the wooden plugs in the steam passages hold the pressure, and several were blown through into the cylinder before the experiment succeeded; with no disastrous effects, of course, for the cylinder ends were open, and the piston stationary.

A test under these conditions, with the balance plate on, showed leakage amounting to 43.9 per cent. of the total steam consumption of the engine as determined by the first tests; when the balance plate was removed, the leakage was 13.9 per cent. of the steam consumpion.

### ADDITIONAL TESTS

In order to verify the assumption previously made that the excessive leakage with the balance plate on was due to imperfect seating of the valve when balanced, tests were run with the balance plate off and with varying pressure in the chest, when it was found that the leakage decreased rapidly as the pressure increased.

As stated before, the engine had been standing idle for some time and the valve and seat were not in perfect order, but their condition was not unusually bad, for when tested in the ordinary manner by opening the throttle with the valve standing still over the ports only a trifling leakage was apparent, which makes it appear that the standing test for leakage, so commonly

used, is a very poor index of what may take place when the valve is running.

In order to determine the effect of the balance plate in reducing the work required to drive the valve gear, the electric motor driving the eccentric was calibrated for efficiency and wattmeter readings taken, giving data for computing the power absorbed by the eccentric and valve under varying conditions. It was found that the power used with the balance plate on was .25 horse-power, and that it remained practically constant for varying pressures in the chest. Without the balance plate, the power required increased with the pressure and amounted to .38 horse-power for the pressure previously used. While the saving shown here is slight, the value of the balance plate for much larger valves is unquestioned, and no doubt results in a net saving when the parts are in perfect working condition, but it would seem that in a small engine receiving the ordinary care, its presence may become detrimental in the course of time, owing to its tendency to increase the leakage due to poor contact between the valve and seat.

## Manufacturing Costs

By R. H. Probert

In a paper upon this subject, read Nov. 17 last before the Ohio Society of Mechanical, Electrical and Steam Engineers, Mr. Probert said, among other things:

There are six chief elements entering into the cost of manufacture, which are are follows: (1) Productive labor, (2) non-productive labor, (3) raw material, (4) waste or scrap. (5) supply and repair to producing departments, and (6) fixed or overhead expense.

Theoretically ascertaining accurately the cost of productive labor is one of the easiest problems dealt with in cost keeping. Practically it is one of the most difficult.

There are various mechanical aids to assist us in this work—time clocks and recorders of several kinds. All of these have their use and help towards accuracy, but all the time clocks in the world will not keep track of the time of the producers unless we have the hearty and intelligent co-operation of our superintendents, foremen and time keepers.

Where the character of the product will permit it, job tickets may be issued to advantage, whereon each workman, his timekeeper or foreman, enters on a card or slip the amount of time devoted to each particular job, these cards or slips being turned in daily to the cost department and the proper charges made by it on appropriate forms. Such a method would be entirely out of the question for a factory having a continuous production, and other methods would have to be devised.

### NON-PRODUCTIVE LABOR

Under this head should be charged all factory employees who are not actual producers. Excepting the superintendent and other factory employees, such as the stockkeeper, night watchman, gatekeeper, etc., the non-producers can usually be charged direct to department costs, and it should always be borne in mind that a direct charge should always be made, if possible, in preference to a pro-rata charge. This rule will greatly increase the accuracy of your costs.

### RAW MATERIAL

All material entering into the construction of the product we sell should be classed as raw material, even though it comes in a partly or wholly finished state.

### WASTE OR SCRAP

If a complete stock room system is in operation, the cost of this item may be ascertained through the stock records. In some factories, a simple system of scrap reports may be installed which will answer the purpose.

### SUPPLY AND REPAIR TO PRODUCING DEPARTMENTS

Under this head should be charged all supply and repair items which can be charged direct to the various departments. This account is kept separate from the general supply and repair account for the reasons before mentioned, that a direct charge to a department is more accurate than any pro-rata charge can be.

### FIXED OR OVERHEAD EXPENSE

Broadly, the fixed or overhead expense account should be charged with every item of expense which cannot be charged direct to a producing department. Charge direct if you can, but remember that all expense items must appear either as a direct or pro-rata charge.

### HOW TO ASCERTAIN OUR COST

It is obvious that the adding together of Items 1, 3, 4 and 5, with either a direct or pro-rata charge of Item 2 (non-productive labor), will give us a part of our cost. Item 6 is, however, yet to be considered. How shall we take care of our fixed or overhead expense, and how shall we carry a proper proportion of it into our cost figures?

While opinions differ largely as to the correct method of figuring the proper proportion of fixed expense to be added to the cost, it is generally agreed that the fixed expenses should be figured against the cost element which fluctuates the least, and this is productive labor.

Our formula for our cost figures will, therefore, be as follows: Add the cost of non-productive labor, waste or scrap, department supply and repair and any other direct charges, together. Add to this the raw material, and to this total add the cost of productive labor, plus a percentage to cover fixed or overhead for a suitable period against the total cost of productive labor for the same period.

# TRADE AND MISCELLANEOUS NOTES

### A Large Air Washer and Humidifier

One of the largest air washers and humidifiers yet built will be installed in School No. 6, New York City. The washing chamber measures 18 ft 6 in. x 14 ft. 10½ in. high, has a sectional area for air passage of 220 sq. ft. and will provide for a total capacity of 110,000 cu. ft. of air per minute with an air velocity of 500 ft. per minute. The washing will be accomplished by 448 spray nozzles, which atomize the wash water by centrifugal action, delivering approximately 3 lbs. of water per minute. This provides a trifle over 43 tons of water per hour for washing, all of which must be taken out of the air again by the 250 eliminator plates (made of No. 24 galvanized sheet iron), only such portion of water vapor remaining in the air as will bring the humidity to the percentage provided by the automatic control. The water for the spray nozzle is furnished by a 3-in. belt driven centrifugal pump, the water level in the settling tank being kept constant by the ¾-in. ball float regulating valve which governs the supply. Two metal doors 16 in. x 36 in., with glass windows, provide access to the washing chamber. The air washer and humidifier is being built by the Buffalo Forge Company, Buffalo, N. Y.

### A Fan and Turbine Engine Combined

Something new in the way of a mechanical fan has been devised by Mr. L. J. Wing, of the Wing Manufacturing Company, 136 Liberty street, New York, which combines a fan and turbine engine in one apparatus and occupies a space no larger than that taken by the fan itself. The fan is especially designed for forced draft for boilers and, with the turbine engine, requires no extra space except that taken by a small pipe running around the outside of the fan and connecting at intervals with the steam nozzles of the turbine. A number of these fans are in successful operation at the St. Regis Hotel, New York.

### Miscellaneous Notes

**Alaska-Yukon-Pacific Exposition** is the official title of a coming World's Fair, which will be held in 1909 at Seattle, Wash., and which will exploit northland and Oriental trade. The fair will cost $10,000,000, and, from the advance reports sent us of the progress of the movement, the success of the exposition is already assured. On October 2nd last, five months after the incorporation of the exposition company, the people of Seattle were called upon to finance the enterprise by subscribing in one day to its capital stock of $500,000. They over-subscribed this amount to the extent of $150,000. It is said that no other city for any purpose has equaled such a feat. Different from other fairs, the Alaska-Yukon-Pacific Exposition will not celebrate any particular event. The awakening of the Pacific, the progress of the countries bordering this ocean and the important role the commerce of the ocean plays in that of the world are the most noteworthy things the fair will celebrate. The exposition site comprises 250 acres of the campus of Washington University. The grounds, for more than a mile and a half, border Lake Union and Lake Washington.

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### Manufacturers' Notes.

**National Tube Co.,** McKeesport, Pa., will have the largest mill building in the world when its new plant at that place is completed. The new buildings will contain more than 20 acres of floor space. They will be constructed in a series forming one structure, of steel and brick, 567 feet in width. The building containing the pipe welding furnaces and machinery for the production of pipe, 1-8 to 36 inches in diameter, will be one-third of a mile long. An extensive ventilating system will be installed for supplying fresh air to the men exposed to excessive heat.

**American Steam Gauge & Valve Mfg. Co.,** Boston, Mass., had its Chicago branch, at 16 North Canal Street, Chicago, entirely destroyed by fire November 20th last. The company has secured temporary quarters at 8 North Canal street.

**Beaton & Corbin Mfg. Co.,** Southington, Conn., has recently enlarged its plant, equipping the new buildings throughout with electric lights.

**United States Radiator & Boiler Co.,** Corry, Pa., will open its new plant, which it is building at that place, about the first of March. The two buildings are each 60x300 feet, fitted up to manufacture cast-iron sectional boilers for house heating. The plant will have modern equipment throughout.

**Norristown Magnesia & Asbestos Co.,** Norristown, Pa., has bought the business of the Norristown Covering Company, Norristown, Pa., and has increased the capital.

**United States Furnace & Foundry Co.,** Minneapolis, Minn., is building a new foundry to cost about $1,000,000.

**Utica Heater Co.,** Utica, N. Y., has taken up quarters in its new building at 94 Lafayette street. The building is 30x50 feet, two stories high and of brick construction, connected in the rear by a two-story brick warehouse, 110x75 feet.

**H. W. Johns-Manville Co.,** New York, has opened a branch office in Baltimore, Md., to care take of its increasing business in that locality. The office is at 315 Equitable Building and is in charge of W. F. Baird, previously connected with the Philadelphia branch of the company

**Buffalo Forge Company,** Buffalo, N. Y., has received an order through its London office, for its large steel plate fans, with self-aligning bearings and built of extra heavy material for use in a heating and ventilating system for the shops of one of the Belgian State Railways. This company has also closed contracts for the following: Heating and humidifying apparatus, with automatic control of humidity for the Klots Throwing Company, New York, and the Peerless Manufacturing Company, Lowell, N. C.; a 40-inch steel plate fan, direct connected to engine, for forced draft, at the Lake Shore Engine Works, Marquette, Mich.; a 170-inch fan, with two water cool bearings, direct connected to 8x10 automatic engine, for induced draft for the W. S. Barston Company, New York; two 110-inch steel plate fans and an 8x8 single, vertical, double-acting engine, with new design open frame for heating and ventilating the gymnasium

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¶ The sales of Norwall Automatic Air Valves are running nearly double those of last year. ¶ The sales of Norwall Automatic Air and Vacuum Valves are running over three times those of last year. ¶ Users of NORWALL VALVES keep on using them. ¶ Enough said—but let us tell you why these facts are true, and show you what these valves will do.

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at Emery College, Oxford, Ga.; a 100-inch fan and 5 1-2x7 direct connected engine for heating the enamel warehouse of the Central Stamping Company, Newark, N. J.; also heating equipment for the roundhouse and machine shop of the Erie Railroad at Susquehanna, also heating and ventilating apparatus for Geophysical laboratory, Carnegie Institution of Washington, Keystone Watch Company, Philadelphia, J. J. Howden Company, Muskegon, Mich., Hood Furnace & Supply Company, Corning, N. Y. and the Flectric Wheel Company, Quincy, Ill.

**H. W. Johns-Manville Co.'s** Boston branch has moved its quarters and is now located in the new building at 55-57-59 High street, Boston. This entire building, which comprises seven floors, will be occupied by the company and the increase of space provided will enable the company to carry a much larger stock on hand to meet the growing demand in this section for the firm's products.

**Union Radiator Co.,** Johnstown, Pa., has passed into the control of Herman E. Baumer through his purchase of the holdings of George Gore, president of the company.

### New Incorporations

**Simonds Heating & Specialty Co.,** Fremont, Mich., has been incorporated with a capital of $40,000 to manufacture heating goods.

**All-Metal Valve Co.,** New Brunswick, N. J., has been incorporated with a capital of $50,000 to manufacture steam specialties. The incorporators are: F. R. Jones, E. H. Hobby and T. R. Patren.

**Federal Plumbing & Heating Co.,** Pittsburg, Pa., has been incorporated by George M. Koser, H. A. Tucker and William F. Neely.

**Ackroyd True Radiator Co.,** Plainfield, N. J., has been incorporated with a capital of $100,000. The incorporators are: William H. Aspinwall, Floyd T. Woodhull and Edson C. Martin.

**Thomas Bonner Heating Co.,** New York, has been incorporated with a capital of $5,000 to install steam and hot water heating and do plumbing work. The incorporators are: T. Bonner, J. F. Curran and E. A. Monfort.

**Philadelphia Pipe Bending Co.,** New Brunswick, N. J., has been incorporated with a capital of $50,000 to manufacture and bend pipe and manufacture valves and fittings. The incorporators are: George M. Harden, Edward Morris and Willard P. Voorhees.

**Virginia Plumbing & Heating Co.,** Richmond, Va., has been incorporated to do a heating, plumbing and tinning business.

**Keystone Ventilating Co.,** Camden, N. J., has been incorporated with a capital of


"W. M. MACKAY"
AUTOMATIC
AIR VALVES
FOR STEAM RADIATORS

Positively the Best Air Valves Made

Steam and Hot Water Valves and Heating Specialties

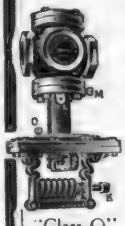
Mackay Manufacturing Co.
New York Office
235 Water St.
62 JAMES STREET
NEWARK, N. J.

FOR low pressure delivery in steam heating a "Class Q" or "Class QH" Valve is specially adapted.

The "Class QH" Valve is specially intended for vacuum systems and has enlarged outlet connections to permit the use of a valve smaller than the delivery pipe.

"Class QH" Valve

Send for a Foster Catalog giving full details of these valves as well as Foster "Class W" Valves Free.


"Class Q" Valve

Exhaust Valves, Float Valves, Pump Governors, etc.

Foster Engineering Co.
Newark, N. J.

$50,000. The incorporators are: E. L. Marple, Frank Adams and M. M. Wilson.

**Standard Humidifier Co.,** New York, has been incorporated with a capital of $25,000 to manufacture ventilating devices. The incorporators are: Charles A. Brodek, New York; Ralph H. Raphael, Montclair, N. J., and Winfield Bouynge, Hoboken, N. J.

**H. R. Boynton Co.,** Los Angeles, Cal., has been incorporated with a capital of $250,000 to deal in pipe, fittings, valves and mill supplies.

### Extravagant Methods in Steam Heating

Some light is thrown on the attitude of a portion, at least, of the steam fitting trade towards central station heating by the following letter, written by a Tacoma (Wash.) engineer regarding a system recently proposed for that city. The system is designed to cover the business section of the city. He says:

Roughly outlined and speaking fairly, but straightforwardly, what do we find?

First—An extensive steam heating system, with mains and sub-mains ramifying over large areas, all piping being conducted under ground in conduits, through alleyways and streets, with the branch steam main into each building.

Second—Instead of a main return pipe installed parallel to the main supply line, for conducting the pure condensed steam back to the power house, we find no provision for saving any condensation whatever, and it is all wasted into the sewers.

Third—Poor service as the plant is extended, due to a greater demand than can be supplied, injuring the general service and at the same time with more cost to the consumer.

Fourth—The use of meters for measuring the condensation placed in the discharge end of the heating system in each building for registering the service charges.

Fifth—The inability to control the individual plant in any way, not allowing any saving in steam consumption.

Sixth—Last, but not least, the excessive rates for service, due to wasteful service and the adoption of meters, besides the charge put upon the consumer for the cooling coils through which the condensation is wasted to the sewer.

In the last item the attention of the consumer is called to the fact that a charge equal to 20 per cent. of the total demanded for heating in each building is made, and whether it is on account of a city ordinance in that city forbidding the discharge of hot condensation directly into the sewer, the iniquity of the scheme is apparent and only serves to accommodate and enrich the promoter at the loss of the consumer.

A service of this nature is indeed welcomed and indicates enterprise and a demand for modern conveniences and com-


# Thermostatic Regulation

as manufactured
and installed by the

# National Regulator Company

is the most simple and effective of any on the market.
For the proper control of Dampers and Valves in a
Heating Apparatus it has NO EQUAL.
Write for Catalogue and find out why.

**CHICAGO**
**334 Dearborn St.**

**NEW YORK**
**1135 Broadway**

fort, but it is due the consumer to know that he is to get the best and most modern economical service when it is just as easy to secure it.

### A Covering for Cold Water Pipes

Considerable trouble, annoyance and expense is caused in cold weather by the freezing of water pipes, especially where these are openly exposed to the outside air. The H. W. Johns-Manville Co., of 100 William street, New York, have a covering which is sold under the trade name of "Zero," which effectively prevents freezing of pipes during cold weather. This covering consists of a combination of hair felt and wool felt. For ordinary conditions, one layer of this covering is sufficient, but where pipes are exposed to the weather, two thicknesses should be used.

### Contracts Awarded

**Elliott & Barry Engineering Co.,** St. Louis, Mo., heating the new McKinley school, at their bid of $5,575.

**Arthur Brothers,** Washington, Ia., installing the steam heating plant in the new school building at Blakesburg, Ia.

**N. J. Daly & Sons,** Waterbury, Conn., installing the automatic sprinklers, heating and plumbing the American Ring Company's Building, also heating the Neary Block at Naugatuck, the Webster school addition; installing a sprinkler in the Farrell Foundry & Machine Company's plant and the power piping at the Johns Pratt Company in Hartford.

**Cleveland Steamfitting & Supply Co.,** Cleveland, Ohio, heating the new public bath house.

**A. F. Mueller,** Des Moines, Ia., heating and plumbing the armory building.

**Edwin Hawes Co.,** Worcester, Mass., heating the new addition to the Union Avenue school.

**Anson & Pratt,** Hastings, Neb., heating the new F. E. Garrett Building.

**Parker & Redman,** Havre de Grace, Md., heating and plumbing the new Masonic Temple.

**William Schelm,** Washington, Ill., installing the steam heating plant in the plant of the Acme Railroad Signal Works.

**Campbell Heating Co.,** Des Moines, Ia., heating the new Methodist Episcopal Church at Lake Mills, Ia., and the new Rosendale Bank in Rosendale, Mo.

**W. D. Ahern,** New London, Conn., heating and plumbing the new officers' storehouse at Plum Island.

**Clifton Plumbing & Heating Co.,** Owatonna, Minn., heating three cottages and the main building at the State public


EMPIRE STATE ENGINEERING COMPANY ENGINEERS AND —MACHINISTS—

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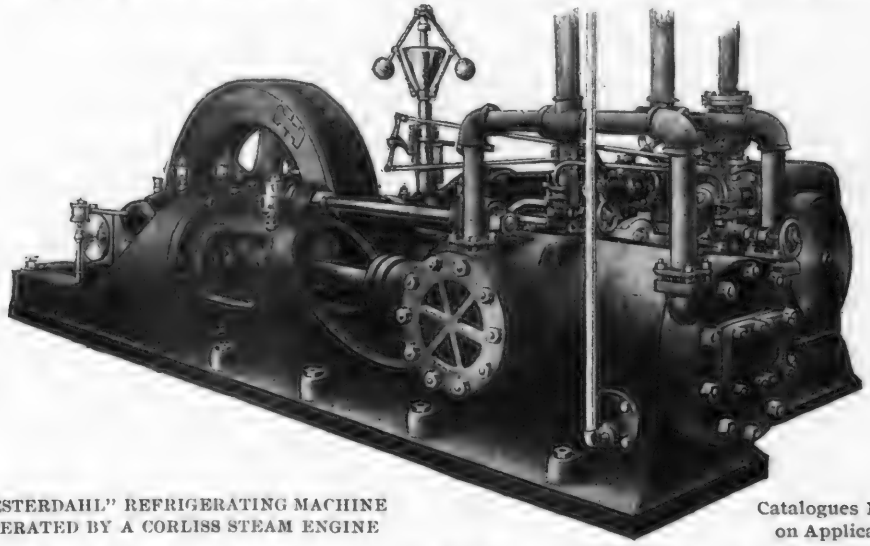
The Maxfield Steam Engine

For belting or direct connecting to dynamos, pumps blowers, stokers, disc fans and general power 3 H. P. to 30 H. P. All speeds. Small space.

*Dust proof, durable, simple, efficient.*



"VESTERDAHL" REFRIGERATING MACHINE
OPERATED BY A CORLISS STEAM ENGINE

Catalogues Mailed on Application

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school. The contract is worth about $4,769.

**A. Hattersley & Sons,** Fort Wayne., Ind., steam heating, plumbing and electric wiring the new wing at the County poor farm. The consideration is $1,212.

**S. H. Morgan,** Detroit, Mich., heating and plumbing the new Home Telephone Company's central exchange.

**J. W. Minton & Co.,** Cannonsburg, Pa., heating and plumbing the new $40,000 Roman Catholic Church.

**W. T. Cantwell,** Utica, N. Y., installing the hot water heating system in the store and factory of Lynch & Kelly; also steam heating the Episcopal Church at Ilion.

**W. D. Theobald & Co.,** Canton, Ohio, heating, plumbing and electric lighting the addition to the County Infirmary. The bid was $3,130.

**O'Toole Bros.,** Clinton, Mass., heating the Webber & Chadwick Block at Leominster and two houses in Marlboro; also heating and plumbing four apartment buildings in Boston.

**Thomas Haverty Co.,** Los Angeles, Cal., heating and plumbing the new Grant Hotel in San Diego. The bid for the heating was $15,000 and for the plumbing, $68,000.

**Andrews Heating Co.,** Minneapolis, Minn., steam heating the Auditorium and Fraternal Hall at Coeur d'Alene, Idaho.

**E. M. Mellon,** Redwood Falls, Minn., heating the new Christian Church.

**A. Dussell & Son,** Columbus, Neb., heating the new Masonic Building in North Platte, at their bid of $3,700.

**Lyman D. Mills,** Middletown, Conn., heating and plumbing the dormitory for Wesleyan University.

**O. E. Lang & Co.,** Mishawaka, Ind., heating the new school building at Wyatt.

**T. H. Ledden,** Ridgway, Pa., heating and plumbing the Elk County National Bank Building at Ridgway and also heating and plumbing twelve residences being built at Johnsonburg, Pa.

**McCarten Plumbing Co.,** Marshalltown, Ia., heating a large three-story building on West Main Street with the vapor vacuum system.

**F. W. Barclay,** Beatrice, Neb., hot-water heating the Newton Clothing Company's building at Wymore.

**American Warming & Ventilating Co.,** Pittsburg, Pa., heating the new $30,000 schoolhouse at Uniontown, Pa., and the Southside Grammar School at Jamestown, N. Y.

**Grebe & Emmerich,** New Ulm, Minn., heating and plumbing the County Poor House.

**C. A. Criqui,** Buffalo, N. Y., heating and plumbing the new Chamber of Commerce Building.

**Freis Heating Co.,** Milwaukee, Wis., heating the convent in St. Nazianz, Wis.

**Snyder Bros.,** Charles City, Ia., installing

# Wing's Disc Fans

## FOR FORCING OR EXHAUSTING AIR

The Original
The Strongest
The Most Efficient

Send for Catalogue and Reference List of some 800 names of users.

MANY THOUSANDS IN USE

**L. J. WING MFG. CO.**
**136 Liberty Street, New York**

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**WING'S Disc Fan and Combinations**
**WING'S Fans and Turbine Engines for Forced Draft, etc.**
**WING'S High Speed Steam Engines**
**WING'S Acetylene Generators, etc.**

a heating plant in the Court House and jail. The contract is worth $1,089

**M. H. Bash,** East Connemaugh, Pa., heating the new hotel belonging to William H. McVey.

**Gordon E. Haslem & Co.,** Providence, R. I., heating and ventilating the Technical High School.

**Spear & Co.,** Geneva, Neb., steam heating the Exeter High School building.

**John G. Sutton,** San Francisco, Cal., installing the steam heating plant in the Union Lithograph Company's new building.

**W. F. Porter & Co.,** Minneapolis, Minn., installing the heating plant in the Federal Building at Eau Claire, Wis. The consideration is $10,051.

**Lewis & Kitchen Co.,** Kansas City, Mo., heating the Whittier school at Edgar, at their bid of $2,700.

**Fritz & Seitzinger,** Reading, Pa., hot water heating the Lutheran Orphans' Home at Topton, Pa.

**Hopson & Chapin Mfg. Co.,** New London, Conn., heating the Konomoc Hose Company's building.

**W. T. Power,** Guthrie, Okla., installing the heating plant in the Agricultural School buildings at Langston. The consideration s $9,000.

**Anderson-Darragh Co.,** Pittsburg, Pa., heating the Mabold Building, East End, Pittsburg,

**George W. Carmichel & Co.,** Akron, Ohio, heating and plumbing the new power plant for the jail.

**Hinton Foundry & Machine Co.,** Hinton, W. Va., heating and plumbing the new Hinton Hotel.

**Frontier Plumbing & Heating Co.,** Buffalo, N. Y., heating and plumbing the new building for the Sisters of Our Lady of Charity; also low and high pressure steam work in the M. Brunner Bakery.

**McGinness-Smith Co.,** Pittsburg, Pa., heating the new pottery being built at Newell, W. Va., and heating the new addition to Westminster College at New Wilmington, Pa.

**R. M. Larkey,** Hartland, Wis., heating the Opera House building.

**Mellott Heating Co.,** Pittsburg, Pa., heating the $20,000 residence at Crafton, Pa.

**B. W. Sheede,** Haywood, Wis., installing the steam heating plant in the court house and jail. The consideration is $1,940.

**James A. North,** Xenia, Ohio, heating and plumbing the $15,000 apartment building for George Dodds & Sons.

**George M. Drake,** Bradford, Pa., heating and plumbing the $10,000 addition to the Bradford Hospital.

**Meagher Heating Co.,** Pittsburg, Pa., heating the new $60,000 school at Bedford avenue and Wandless street.

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**William H. Pfahler,** president of the Model Heater Co., Philadelphia, Pa., sailed for Southern Italy, November 15th last.

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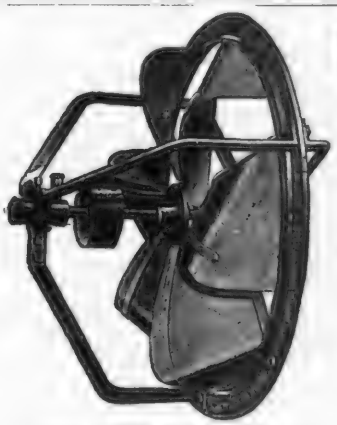
### Business Troubles

**William C. Powell,** New York, has filed a petition in bankruptcy. The liabilities are $14,679 and no assets. Among the creditors are: Nason Manufacturing Com-

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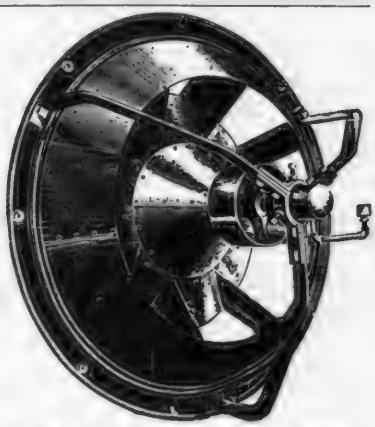
The Blackman and Duplex Cone Types



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WITH DIRECT CONNECTED ELECTRIC MOTORS OR STEAM ENGINES

FOR CATALOGUES, LIST OF USERS, SURVEYS AND ESTIMATES, ADDRESS

**HOWARD & MORSE, 45 Fulton St., New York**

MANUFACTURERS, ENGINEERS AND CONTRACTORS

pany, $1,535; Pierce, Butler & Pierce Manufacturing Company, $4,100 and the A. A. Griffing Iron Company, $2,156.

### Chances for Business

**Washington, D. C.** Sealed proposals will be received at the Office of the Supervising Architect, Treasury Department, until 3 P. M., January 2, 1907, for the construction (including heating apparatus, electric wiring and conduits) of the extension to the U. S. Post Office at Wausau, Wis.

**Washington, D. C.** Sealed proposals will be received at the office of the Supervising Architect, Treasury Department, until 3 o'clock P. M., January 15, 1907, for the construction of an extension, including heating apparatus, electric wiring and conduits, to the U. S. Court House, Post office, etc., at Dallas, Texas.

**Washington, D. C.** Sealed proposals will be received at the Office of the Supervising Architect, Treasury Department, until 3 P. M., January 7, 1907, for the construction (complete) of the extension to the U. S. Post Office and Custom House at Newport, R. I.

**State Emergency Board,** Columbus, Ohio, have planned to have a heating plant, to cost about $7,000, installed at the Ohio University.

**New York Securities Co.,** Buffalo, N. Y., will install a central steam heating plant in this city.

**Wanted** a bright young man who has been brought up in the Heating Business; one that can estimate, understands draughting and has some executive ability; must have temperate habits and good reference. Address Raisler Heating Co., 17 E. 22d St. N. Y. City.

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**For Plumbers and Steam Fitters**

Gives methods of installing steam and hot water heating plants and improved sanitary plumbing, together with information for gas fitters.

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**WEBSTER SYSTEM OF STEAM CIRCULATION**

discovered the way to circulate steam at low pressure, or with no pressure at all. This system keeps you always warm enough, but never too warm; and using only just enough steam to do the work means a very great saving of money that is wasted by other systems.

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is superior to any other method for this purpose. It shows 88% efficiency as compared with bare pipe and will carry any pressure steam over a mile. This Conduit is practically indestructible and its cost of maintenance comparatively nothing.

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# THE HEATING AND VENTILATING MAGAZINE

VOL. III NEW YORK, DECEMBER, 1906 NO. 12


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Reducing Valves and Steam Traps for all services; Damper Regulators, Back Pressure and Relief Valves, Grease Extractors and Steam Separators, Pump Governors, Pump Regulators, Float Valves, Water Arches, Hot Water Temperature Controllers, Water Feeders, etc.

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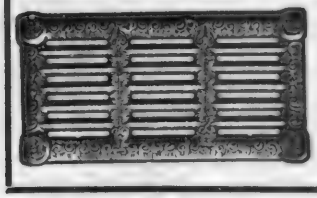
**Steam Specialties**



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ORIGINATORS OF WALL RADIATION

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WE GUARANTEE OUR WALL RADIATION:

To contain the rated surfaces.
To have been tested at 100 lbs. pressure before shipment.
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Double Connection
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*A Guaranteed Valve*

**No. 1. Price, $1.15**
***Side Outlet, with Cap***

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***Side Outlet—Lock Shield***

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***Bottom Outlet, ⅛ or ¼ inch***

These valves are the best made in every respect. Small holes and tubes are avoided, to prevent clogging. Being fitted with Double passages into the Radiator, all danger of throwing water and water clogging is eliminated. The Expansion post is made of an indestructible, highly sensitive compound, insuring quick action. The Workmanship is perfect, the Plating extra heavy and every valve tested and guaranteed for five years.

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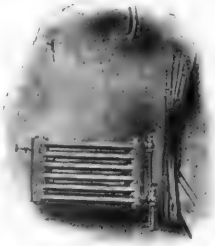

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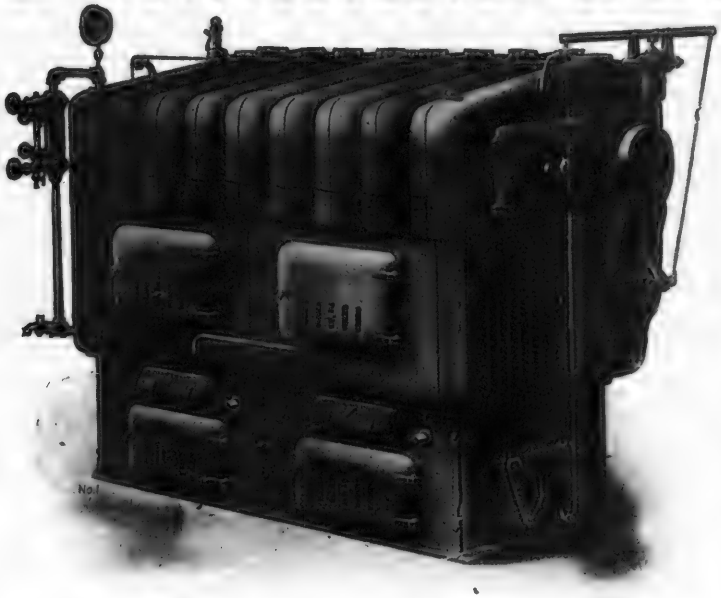

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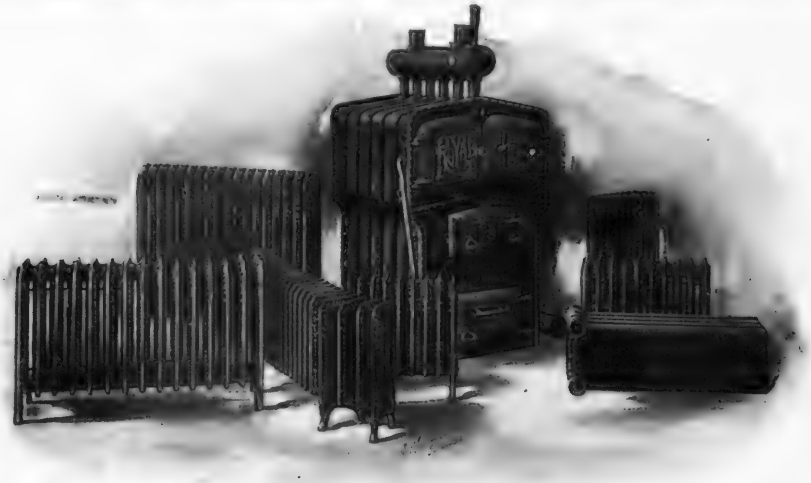

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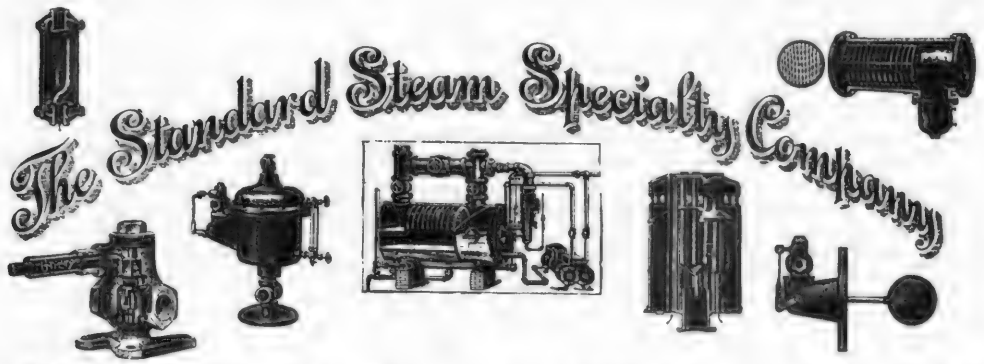

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Utility Pump Governor Valve and Head

Utility Pump Governor Valve

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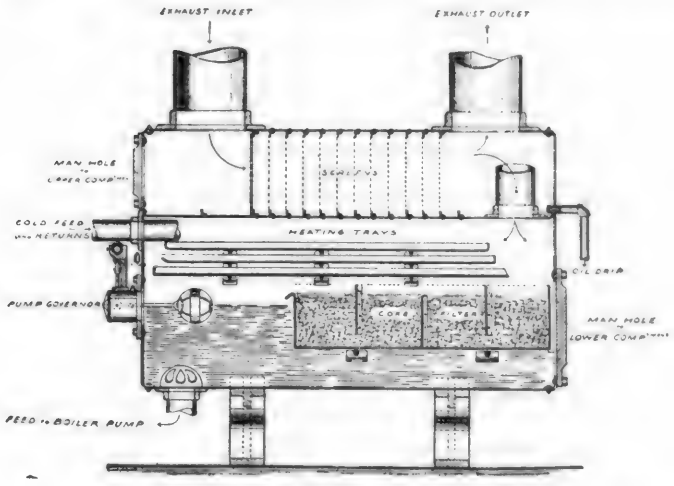


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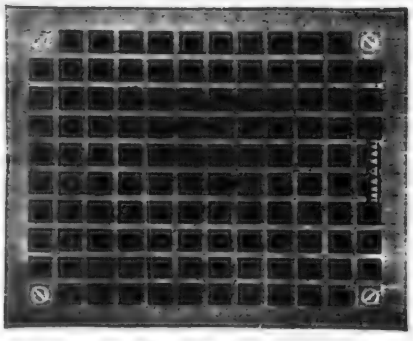

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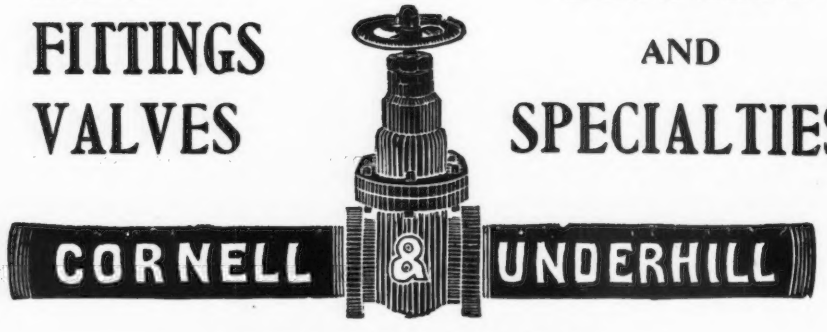


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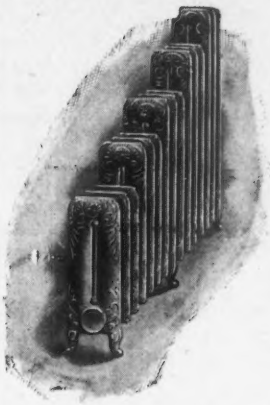

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